SUMMARY OF INTERIM REMEDIAL INVESTIGATIONS JANUARY 1987 THROUGH APRIL 1989 VOLUME 2 OF 3 NAS FORT WORTH TX

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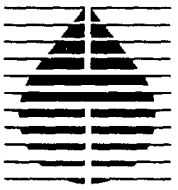
July 19, 1989

SUMMARY OF INTERIM REMEDIAL INVESTIGATIONS
JANUARY 1987 TO APRIL 1989
U.S. AIR FORCE PLANT NO. 4
FORT WORTH, TEXAS

VOLUME II
APPENDICES A - F



HARGIS+ASSOCIATES, INC.

Consultants in Hydrogeology

Tucson/Phoenix/San Diego

SUMMARY OF INTERIM REMEDIAL INVESTIGATIONS

JANUARY 1987 TO APRIL 1989

U.S. AIR FORCE PLANT NO. 4

FORT WORTH, TEXAS

VOLUME II

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Appendix A

APPENDIX A

LITHOLOGIC LOGS FOR

SOIL BORINGS

APPENDIX A

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TABLE A-1

LITHOLOGIC LOG OF SOIL BORING RSB-1; MONITOR WELL HM-95

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 7.0	CLAY	CH	Reddish (5 YR 4/20 very cohesive, plastic.
7.0 - 20.0	SANDY SILTY CLAY	CL	Gray orange (10 YR 7/4) moderately cohesive, plastic; approximately 20 percent silt; sand is varicolored, very fine to very coarse grained.
20.0 - 26.0	CLAY	CH	Buff (10 YR 7/4) very plastic, very cohesive.
26.0 - 40.0	SANDY SILT-SILTY SAND	SM	Red brown (10 YR 5/4); silt is sand is fine to very fine grained; slightly cohesive, slightly plastic.
40.0 - 44.5	GRAVELLY SAND	GP	Varicolored, subrounded, medium to very coarse grained sand, medium grained gravel.
44.5 - 45.0	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8) angular chips of shell fragments (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 45 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-2

LITHOLOGIC LOG OF SOIL BORING RSB-2

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 5	CLAY	CH	Red (5 YR 4/2) very cohesive, very plastic.
5 - 7	GRAVELLY SANDY SILT	ML	Red brown (5 YR 4/2) 50 percent silt, 20 percent sand, 30 percent gravel, silt is noncohesive, nonplastic; sand subrounded to subangular, medium- to coarse-grained; gravel is subangular, medium-grained.
7 - 9	CLAY	CH	Red brown (5 YR 4/2) very cohesive, very plastic.
9 - 16	GRAVELLY SANDY SILT	ML	Red brown (5 YR 4/2) silt noncohesive, nonplastic; sand is subangular to subrounded, medium- to coarse-grained; gravel is subrounded fine-grained.
16 - 19	CLAY	CH	Red brown (5 YR 4/2) very cohesive, very plastic.
19 - 21	GRAVELLY SILT	GM	Red brown (10 YR 5/4) silt is slightly cohesive, slightly plastic; gravel subrounded, medium-grained.
21 - 25	CLAY	CH	Buff (10 YR 7/4) very plastic, very cohesive.
25 - 41	SILTY SAND-SANDY SILT	SM	Yellow brown (10 YR 5/4) nonplastic, noncohesive; sand is fine- to very fine-grained, subrounded.
41 - 45	GRAVELLY SAND	SW	Varicolored, subrounded, medium- to very coarse-grained sand, medium-grained gravel.

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-2 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-2

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
45 - 45.5	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8) angular brittle shards, abundant shell fragments. (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 45.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-3

LITHOLOGIC LOG OF SOIL BORING RSB-3

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 5	CLAY	CH	Red (5 YR 4/2) very cohesive, very plastic.
5 - 7	CLAY	CH	Buff (10 YR 7/4) very plastic, very cohesive.
7 - 18.5	SILTY CLAY-CLAY SILT	CL	Gray orange (10 YR 7/4) moderately cohesive, moderately plastic.
18.5 - 24.5	GRAVELLY SANDY SILT	SM	Red brown (5 YR 4/2) silt is slightly plastic, slight cohesive.
24.5 - 26	SILTY SAND-SANDY SILT	SM	Yellow brown (10 YR 5/4) nonplastic, noncohesive; sand is well rounded, very fine-grained.
26 - 28.5	SANDY GRAVEL	GP	Varicolored, subrounded, sand is fine- to very coarse-grained, gravel is fine- to medium-grained.
28.5 - 29	CLAY	CH	Buff (10 YR 7/4) very plastic, very cohesive.
29 - 40	SILTY SAND-SANDY SILT	SM	Yellow brown (10 YR 5/4) nonplastic, noncohesive; sand is very fine-grained to medium-grained, subrounded.
40 - 45	SANDY GRAVEL	GP	Varicolored, well rounded to subrounded grains, medium to very coarse sand, medium- to very coarse-grained gravel.
45 - 45.5	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 7) brittle angular shards (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 45.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by Mud Rotary

TABLE A-4

LITHOLOGIC LOG OF SOIL BORING RSB-4

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 7	SANDY CLAY	CL	Red brown (5 YR 4/2) moderately plastic, cohesive; sand is white, subangular, medium- to very coarse-grained.
7 - 12	SANDY SILT-SILTY SAND	SM	Buff (10 YR 5/4) slightly cohesive, slightly plastic; sand is very fine-grained, well rounded.
12 - 26	SILTY CLAY	CL	Buff (gray orange (10 YR 7/4) moderately cohesive, plastic; small sand stringer at 20 to 21 feet.
26 - 33	SILTY SAND-SANDY SILT	SM	Red brown (5 YR 4/2) noncohesive, nonplastic; sand is very fine-grained, well rounded.
33 - 37	SILTY SAND WITH GRAVEL	SP	Varicolored; sand is subrounded, medium- to very coarse-grained; gravel is subrounded, fine- to medium-grained.
37 - 44.5	GRAVELLY SAND	SP	Varicolored, subrounded, fine- to very coarse sand and gravel.
44.5 - 45	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8) brittle angular shell fragments (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 45 Feet

*Unified Soil Classification System
ASTM D-2487

TABLE A-5

LITHOLOGIC LOG OF SOIL BORING RSB-5

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 8	SILTY CLAY WITH COARSE SAND	CL	Red brown (5 YR 4/2) moderately cohesive, slightly plastic; sand is white, subangular, very coarse-grained, less than 5 percent.
8 - 12	GRAVEL	GP	Varicolored, fine- to very coarse, angular to subangular fragments.
12 - 30	SANDY SILT	ML	Buff (10 YR 5/4) noncohesive, slightly plastic, sand, approximately 30 percent, very fine- to fine-grained, well rounded.
30 - 35	SILTY SAND	SM	Varicolored, sand is fine- to very coarse-grained, well rounded; silt is red brown (5 YR 4/2) noncohesive, nonplastic.
35 - 43.5	GRAVELLY SAND	SP	Varicolored, subangular to subrounded grains, medium to very coarse sand, fine- to medium-grained gravel.
43.5 - 48	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8) brittle angular shell fragments (Walnut Formation); (clay layers at 44.5 to 45 feet and 46.5 to 46.8 feet).
48 - 58.5	MASSIVE LIMESTONE	--	Gray (N 4) dense, hard; gray clay at 56.5 to 57 feet.
58.5	SANDY CLAY	CL	Gray (N 8) moderately cohesive, moderately plastic; sand is very fine-grained, well rounded.

TOTAL DEPTH OF BOREHOLE: 58.5 Feet

*Unified Soil Classification System
ASTM D-2487

TABLE A-6

LITHOLOGIC LOG OF SOIL BORING RSB-6

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 7	SILTY CLAY WITH SAND	CL	Red brown (5 YR 4/2) moderately cohesive, moderately plastic; sand <5 percent, coarse, subangular grains.
7 - 26	SANDY SILTY CLAY	CL	Buff to red brown (5 YR 4/2 to 10 YR 5/4) moderately cohesive, moderately plastic; sand is very fine-grained, well rounded.
26 - 36	SILTY SAND	SM	Red brown (5 YR 4/2) sand is fine-grained with some coarse grains; approximately 25 percent silt, nonplastic, noncohesive.
36 - 43.5	GRAVEL	GP	Varicolored, subangular to subrounded grains, medium to very coarse.
43.5 - 44	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8) brittle angular shell fragments (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 44 Feet

*Unified Soil Classification System
ASTM D-2487

TABLE A-7

LITHOLOGIC LOG OF SOIL BORING RSB-7; MONITOR WELL HM-96

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 4.0	CLAY WITH SAND	CL	Red brown (5 YR 4/2) dry, plastic, cohesive; less than 5 percent sand, coarse grained, subangular fragments.
4.0 - 6.0	SANDY GRAVEL	GP	Varicolored, coarse grained, subrounded.
6.0 - 32.0	SANDY CLAY	CL	Buff (10 YR 7/4) moderately plastic, cohesive; sand is varicolored, coarse grained, subangular, approximately 20 percent.
32.0 - 40.0	SILTY CLAY	CL	Red brown (5 YR 4/2) slightly cohesive, moderately plastic; some fine sand, less than 5 percent, very fine grained.
40.0 - 47.0	SILTY SAND	SM	Red brown (5 YR 4/2); sand is well rounded, medium to very coarse grained; silt is nonplastic, noncohesive.
47.0 - 52.5	GRAVEL	GP	Varicolored, subrounded grains, fine to very coarse grained.
52.5 - 54.0	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8), brittle angular shell fragments (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 54 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-8

LITHOLOGIC LOG OF SOIL BORING RSB-8

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 9	SANDY SILT	ML	Red brown (5 YR 4/2) with varicolored grains, angular, medium to very coarse.
9 - 40	SANDY SILTY CLAY	CL	Gray orange (10 YR 7/4) moderately cohesive, slightly plastic; approximately 25 percent sand, very fine- to medium-grained, varicolored.
40 - 51	SANDY GRAVEL, GRAVELLY SAND	GP	Varicolored subrounded to subangular.
51 - 54	GRAVEL	GW	Varicolored, subrounded, very coarse-grained.
54 - 57.5	FOSSILIFEROUS LIMESTONE	--	Gray (N 7) brittle angular shell fragments, some very coarse fossil fragments (oysters) Walnut Formation.
57.5 - 66	CLAYEY SANDSTONE	SC	Green gray (5 G 6/1) approximately 80 percent sandstone, very fine-grained, well rounded, approximately 20 percent clay, moderately plastic, moderately cohesive.
66 - 74	CLAY	CH	Olive gray (5 Y 4/1) very plastic, very cohesive, minor very fine sand.
74 - 79.5	CLAYEY SAND	SC	Green gray (5 G 6/1) very fine sand, approximately 90 percent, 10 percent clay, moderately plastic, moderately cohesive.

TOTAL DEPTH OF BOREHOLE: 79.5 Feet

*Unified Soil Classification System
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TABLE A-9

LITHOLOGIC LOG OF SOIL BORING RSB-9; MONITOR WELL HM-97

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 7	TOP SOIL AND SANDY SILT	ML	Brown (10 R 3/4) varicolored, angular grains, 35 percent sand, medium to very coarse; silt is nonplastic, noncohesive.
7 - 35	SILTY SANDY CLAY	CL	Gray orange (10 YR 7/4) moderately cohesive, moderately plastic.
35 - 43	CLAY	CH	Yellow brown (10 YR 5/4) very plastic, very cohesive.
43 - 47	GRAVELLY SAND	GP	Varicolored, well rounded, medium to very coarse-grained.
47 - 51	GRAVEL	GP	Varicolored, well rounded, fine- to very coarse-grained.
51 - 51.5	FOSSILIFEROUS LIMESTONE	--	Gray (N 7 to N 3) brittle angular shell fragments (Walnut Formation).
51.5 - 71	CLAYEY SAND	SC	Gray (N 7) very fine-grained, slightly cohesive, nonplastic.
71 - 76	SANDY CLAY	CL	Gray (N 5 to N 4) moderately cohesive, slightly plastic; approximately 10 percent very fine sand.
76 - 76.25	SANDSTONE	SW	Light gray (N 8) very well cemented, very fine-grained, hard, brittle.
76.25 - 80	CLAYEY SANDSTONE	SC	Gray (N 7) very fine-grained, well rounded, approximately 70 percent sand.

TOTAL DEPTH OF BOREHOLE: 80 Feet

*Unified Soil Classification System
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TABLE A-10

LITHOLOGIC LOG OF SOIL BORING RSB-10

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 5	CLAY	CH	Dark brown (10 R 2/2) plastic, cohesive.
5 - 7	SANDY SILT	ML	Brown (10 R 3/4) slightly cohesive, slightly plastic; approximately 20 percent sand, varicolored grains but mostly white, subangular, medium to coarse grained.
7 - 44	SILTY SANDY CLAY	CL	Gray orange (10 YR 7/4) moderately cohesive, moderately plastic; sand is subangular, fine- to medium-grained.
44 - 45	SAND	SW	Varicolored, subrounded, medium to very coarse-grained.
45 - 60.5	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 7) brittle angular shell fragments (Walnut Formation).
60.5 - 63	CLAY	CH	Gray (N 5 to N 7) very plastic, very cohesive.
63 - 79	INTERBEDDED SAND AND CLAY	SC	Gray (N 5 to N 8) sand is very fine-grained, well rounded, clay is moderately plastic, moderately cohesive. Unable to distinguish separate units.

TOTAL DEPTH OF BOREHOLE: 79 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-11

LITHOLOGIC LOG OF SOIL BORING RSB-11

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 9	SILTY SAND	SM	Buff (10 R 3/4) varicolored grains, predominantly white, angular to subangular, medium- to very coarse-grained; silt is slightly cohesive, nonplastic.
9 - 20	INTERBEDDED SILTY CLAY - CLAY SILT	CL	Buff (10 R 3/4) moderately cohesive, moderately plastic.

TOTAL DEPTH OF BOREHOLE: 20 Feet

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**Drilled by flight auger

TABLE A-12

LITHOLOGIC LOG OF SOIL BORING RSB-12

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 5	CLAY	CH	Black (N 2) very cohesive, very plastic.
5 - 11	SILTY SAND	SM	Silt is red brown (5 YR 4/2) sand is approximately 60 percent, varicolored, angular to subangular, medium- to very coarse-grained.
11 - 40	SILTY CLAY	CL	Gray orange (10 YR 7/4) moderately plastic, moderately cohesive.
40 - 49.5	GRAVEL	GP	Varicolored, medium-to very coarse-grained, subrounded to subangular.
49.5 - 51	CLAY	CH	Dark gray (N 3) plastic, cohesive (Walnut Formation).
51 -58.25	INTERBEDDED FOSSILIFEROUS LIMESTONE AND CLAY	--	Gray (N 3 to N 8) limestone very hard, brittle angular shell fragments; clay very plastic, very cohesive. Clay from 56 to 57 feet same as 49.5 to 51 feet.
58.25 - 60	CLAYEY SANDSTONE	SC	Light gray (N 7) very fine-grained, well rounded, approximately 80 percent sand.

TOTAL DEPTH OF BOREHOLE: 60 Feet

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TABLE A-13

LITHOLOGIC LOG OF SOIL BORING RSB-13

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 3	CLAY	SH	Black (N 3) very cohesive, very plastic.
3 - 33.5	SILTY CLAY - CLAY SILT	CL	Gray orange (10 YR 7/4) moderately plastic, moderately cohesive.
33.5 - 37	CLAY	CH	Gray orange (10 YR 7/4) very cohesive, very plastic.
37 - 39	SAND	SP	Varicolored, subrounded to rounded, fine to very coarse grains.
39 - 51	GRAVEL	GP	Varicolored, subrounded to well rounded, medium-to very coarse-grained.
51 -56.25	FOSSILIFEROUS LIMESTONE	--	Gray (N 5 to N 7) brittle angular shell fragments (Walnut Formation).
56.25- 60	CLAYEY SANDSTONE	SC	Gray (N 5 to N 7) sand is very well cemented, very fine-grained, well rounded; clay approximately 15 percent, slightly plastic, slightly cohesive.

TOTAL DEPTH OF BOREHOLE: 60 Feet

*Unified Soil Classification System
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TABLE A-14

LITHOLOGIC LOG OF SOIL BORING RSB-14

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 7	CLAY	CH	Black (N 3) very cohesive, very plastic.
7 - 11	CLAY	CH	Olive brown (5 Y 4/1) very cohesive, very plastic.
11 - 14	SILTY CLAY - CLAY SILT	CL	Gray orange (10 YR 7/4) moderately plastic, moderately cohesive.
14 - 21	GRAVEL	GP	Varicolored, subangular to subrounded, medium-to very coarse-grained.
21 - 30	SANDY CLAY	CL	Yellow gray (5 Y 8/1) slightly cohesive, nonplastic; sand approximately 10 percent, very fine-grained, well rounded.
30 - 37	LIMESTONE	--	Tan (5 YR 6/4) angular brittle fragments (Goodland limestone).
37 - 40	FOSSILIFEROUS LIMESTONE	--	Gray (N 5 to N 7) angular brittle shell fragments (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 40 Feet

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*Unified Soil Classification System
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TABLE A-15

LITHOLOGIC LOG OF SOIL BORING RSB-15

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 6	CLAY	CH	Black (N 3) very cohesive, very plastic.
6 - 11.5	SILTY CLAY - CLAY SILT	CL	Gray orange (10 YR 7/4) moderately cohesive, moderately plastic.
11.5 - 21	SANDY SILT	ML	Gray orange (10 YR 7/4) plastic, cohesive; minor gravel, white (N 9) subangular, medium-to fine-grained.
21 - 26	SANDY SILT	ML	Red brown (5 YR 4/2) slightly plastic, noncohesive; sand is fine-to medium-grained, well rounded.
26 - 37.5	CLAY	CH	Gray orange (10 YR 7/4) very plastic, very cohesive.
37.5 - 53.5	GRAVELLY SAND	SW	Varicolored, medium-to very coarse-grained sand and gravel, subrounded to subangular.
53.5 - 56	FOSSILIFEROUS LIMESTONE	--	Gray (N 5 to N 7) angular brittle shell fragments (Walnut Formation).
56 - 64	CLAYEY SAND	SC	Gray (N 6 to N 8) sand is very fine-grained, well rounded; clay is nonplastic, noncohesive.
64 - 66	CLAY	CH	Gray (N 4 to N 6) very plastic, moderately cohesive.

TOTAL DEPTH OF BOREHOLE: 66 Feet

**Drilled by flight auger

*Unified Soil Classification System
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TABLE A-16

LITHOLOGIC LOG OF SOIL BORING RSB-16; MONITOR WELL HM-98

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.0	CLAYEY SILT	ML	Moderate brown (5 YR 3/4), slightly cohesive, dry.
1.0 - 6.5	SILTY CLAY	CL	Dusky brown (5 YR 2/2), cohesive, moderately plastic, dry.
			At 3.5-4.0 feet, color change to moderate brown (5 YR 4/4).
6.5 - 14.0	CLAYEY SILT	ML	Moderate brown (5 YR 4/4), slightly cohesive, nonplastic, dry.
			At 9.0-14.0 feet, color change to dark yellowish orange (10 YR 6/6), less clay.
14.0 - 19.0	SANDY GRAVEL	GM	Dark yellowish orange (10 YR 6/6), gravel is varicolored, fine- to coarse-grained, angular to subrounded; sand is fine to coarse; dry.
19.0 - 25.0	SANDY SILT	SM	Dark yellowish orange (10 YR 6/6) with whitish streaking, silt is moderately cohesive; sand is fine-grained; dry to 23.0 feet.
			At 23.0 feet, color change to very pale orange (10 YR 8/2), moist.
25.0 - 31.0	SILTY GRAVELLY SAND	GM	Varicolored, sand and gravel are fine- to coarse-grained, subangular to subrounded grains.
			At 28.75 feet, saturated, more fine sand and silt, less gravel.

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TABLE A-16 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-16; MONITOR WELL HM-98

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
31.0 - 31.5	DENSE LIMESTONE	--	Tan, no fossils, dry.

TOTAL DEPTH OF BOREHOLE: 97 Feet

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TABLE A-17

LITHOLOGIC LOG OF SOIL BORING RSB-17

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 4.5	SILTY CLAY	CL	Moderate brown (5 YR 3/4), cohesive, moderately plastic, dry.
4.5 - 12.5	CLAYEY SILT	ML	Dusty brown (5 YR 2/2), cohesive, plastic, very slightly damp, minor well rounded medium-grained gravel.
12.5 - 17.0	CLAYEY SILTY SAND		Red brown (5 YR 4/4), slightly plastic, slightly cohesive, sand is very fine-grained, less than 10 percent, dry.
17.0 - 18.0	GRAVELLY SAND	GP	Varicolored, gravel is very coarse, subangular, sand is fine- to coarse-grained, subangular to subrounded.
18.0 - 25.5	SILTY SAND	SM	Red brown (5 YR 4/4), very fine-grained, subrounded, dry.
25.5 - 28.0	SANDY GRAVEL		Varicolored, moderately cemented, medium- to very coarse-grained, subrounded to well rounded.
28.0 - 28.25	FOSSILIFEROUS LIMESTONE	--	Light gray (N2), dense, minor fossil fragments, Walnut Formation.

TOTAL DEPTH OF BOREHOLE: 28.25 FEET

*Unified Soil Classification System
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TABLE A-18

LITHOLOGIC LOG OF SOIL BORING RSB-18; MONITOR WELL HM-99

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 5.0	CLAYEY SILT	ML	Moderate brown to dusky yellowish brown (5 YR 3/4 to 10 YR 2/2), moderately cohesive, nonplastic, moist.
5.0 - 9.0	SILT	MH	Light brown to moderate yellowish brown (5 YR 5/6 to 10 YR 5/4), slightly cohesive, nonplastic; some fine- to coarse-grained whitish limestone gravel and sand as stringers; some clay; moist.
9.0 - 11.0	GRAVELLY SILT	GM	Light brown to moderate yellowish brown (5 YR 5/6 to 10 YR 5/4), noncohesive; gravel is medium- to coarse-grained, subangular to subrounded.
11.0 - 27.0	CLAYEY SILT	ML	Light brown to moderate yellowish brown (5 YR 5/6 to 10 YR 5/4), slightly cohesive, nonplastic; moist. At 25.0 feet, TIP reading was 10-40 ppm. At 25.0-27.0 feet, whitish caliche, friable.
27.0 - 38.5	SANDY SILT-SILTY SAND	SM	Light brown (5 YR 5/6), slightly cohesive, sand is fine-grained. At 30.0 feet, TIP reading was 7.5 ppm. At 33.0 feet, saturated. At 35.0 feet, TIP reading was 15-20 ppm.

**Drilled by flight auger

*Unified Soil Classification System ASTM D-2487

TABLE A-18 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-18; MONITOR WELL HM-99

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
38.5 - 44.0	SANDY GRAVEL	SP	Varicolored, sand and gravel are fine to coarse, some oyster fossils in gravel, loose; trace limestone and very well cemented, coarse-grained sandstone, angular to subangular.
44.0	DENSE LIMESTONE	--	Auger refusal, no cuttings obtained in core.

TOTAL DEPTH OF BOREHOLE: 44.0 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-19

LITHOLOGIC LOG OF SOIL BORING RSB-19

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 6.0	CLAYEY SILT-SILTY CLAY	ML-CL	Grayish brown to moderate brown (5 YR 3/2 to 5 YR 4/4) moderately cohesive, nonplastic; trace gravel; moist.
6.0 - 10.5	CLAYEY SILT	ML	Olive gray (5 YR 3/2) cohesive, nonplastic; moist.
10.5 - 14.5	CLAYEY GRAVEL	GC	Varicolored but white is predominant, fine to coarse, subangular to subrounded; clay is slightly cohesive, nonplastic, unit is oxidized; dry.
14.5 - 25.0	SILTY CLAYSTONE	--	Gray (N 5 to N 8) very hard to hard, subangular to angular, blocky. oxidized, dry.
			At 21.0-25.0 feet, more oxidation.
25.0	DENSE LIMESTONE	--	Gray (N 5 to N 7) no fossils, trace pyrite, dry.

TOTAL DEPTH OF BOREHOLE: 25 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-20

LITHOLOGIC LOG OF SOIL BORING RSB-20

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 7.0	SILTY CLAY	CL	Moderate brown (5 YR 3/4) cohesive, nonplastic, moist.
7.0 - 11.0	CLAYEY GRAVEL	GC	Varicolored, fine to coarse, angular to subrounded, oxidized; clay is gray (N 7 to N 8); dry.
11.0 - 15.0	SILTY GRAVEL	GM	Varicolored, fine to coarse, angular to subrounded; silt is light brown (5 YR 5/6); trace fine sand; dry.
15.0 - 18.0	SILTY CLAYSTONE	--	Gray (N 5 to N 8) oxidized, dry.
18.0	DENSE LIMESTONE	--	Very light gray to whitish (N 8 to N 9) no visible fossils; dry.

TOTAL DEPTH OF BOREHOLE: 18.0 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-21

LITHOLOGIC LOG OF SOIL BORING RSB-21

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 20	SILTY CLAY-CLAYEY SILT	CL-ML	Moderate brown (5 YR 3/4) slightly cohesive, nonplastic; trace fine- to medium-grained gravel; dry. At 0.0-5.0 feet, abundant organic matter. At 6.0 feet, color change to light brown (5 YR 6/4) with calcium streaking. At 15.0-20.0 feet, more silt, moist.
20.0 - 28.0	SANDY SILT-SILTY SAND	SM	Light brown (5 YR 6/4) slightly cohesive; sand is very fine to coarse; trace medium to coarse, angular gravel. At 25.0-28.0 feet, very damp, more sand, some gravel, trace cobbles.
28.0 - 30.0	CLAYEY LIMESTONE	--	Gray (N 7 to N 8) friable, dry.

TOTAL DEPTH OF BOREHOLE: 30.0 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-22

LITHOLOGIC LOG OF SOIL BORING RSB-22

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 35.0	CLAYEY SILT-SILTY CLAY	ML-CL	Moderate brown (5 YR 3/4) slightly cohesive, nonplastic, trace medium- to coarse-grained limestone; moist. At 4.5 feet, color change to light brown (5 YR 6/4). At 10-15 feet, silt is dominant. At 15-25 feet, clay is dominant. At 25-30 feet, silt is dominant.
30 - 30.5	GRAVELLY SAND	SP	Light brown (5 YR 6/4) sand is fine- to medium-grained; gravel is varicolored, fine- to coarse-grained; minor cobbles of limestone; saturated. At 30-31 feet, mostly sand and fine gravel.
35.5 - 40.5	SILTY SAND	SM	Light brown (5 YR 6/4) sand is very fine- to fine-grained; moderately cohesive; minor clay.
40.5 - 49.0	GRAVELLY SAND	SP	Varicolored, sand is fine- to medium-grained; gravel is fine to coarse, subangular to subrounded; some cobbles of limestone. At 44.5-47 feet, sandy clay, light brown (5 YR 6/4) dense, cohesive, slightly plastic, sand is fine- to medium-grained.

**Drilled by flight auger

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TABLE A-22 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-22

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
49.0	LIMESTONE	--	Gray (N 6 to N 7) powdered, pulverized on auger teeth.

TOTAL DEPTH OF BOREHOLE: 49.0 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-23

LITHOLOGIC LOG OF SOIL BORING RSB-24; MONITOR WELL HM-111

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 3.0	SILTY CLAY	CL	Moderate brown (5 YR 4/4), moderately cohesive, nonplastic, moist.
3.0 - 5.0	SILT	MH	Grayish orange (10 YR 7/4), noncohesive, friable; minor gravel and caliche, gravel is subangular to rounded, fine- to medium-grained, varicolored, limestone; moist.
5.0 - 15.0	SANDY SILTY GRAVEL	GM	Varicolored gravel, fine- to coarse-grained, angular to well-rounded; silt is noncohesive; sand is fine-grained; silt and sand vary in color from pinkish gray to light brown (5 YR 8/1 to 5 YR 6/4). At 13.0-13.5 feet, pure fine sand.
15.0 - 28.0	CLAYEY SILT	ML	Light brown (5 YR 5/6), slightly cohesive, nonplastic; trace gravel, subangular to rounded; moist.
28.0 - 43.0	SANDY SILT	SM	Light brown (5 YR 5/6), slightly cohesive, nonplastic; trace gravel, subangular to rounded; moist. At 30.0 feet, TIP reading was 50-60 ppm. At 32.0 feet, saturated. At 35.0 feet, TIP reading was 5-6 ppm.
43.0 - 49.0	SILTY SANDY GRAVEL	GM	Varicolored, loose, fine- to coarse-grained; silt is light brown (5 YR 5/6), slightly cohesive.

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*Unified Soil Classification System
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TABLE A-23 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-24; MONITOR WELL HM-111

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
49.0 - 53.0	FOSSILIFEROUS LIMESTONE	--	Medium bluish gray to light bluish bray (5 B 5/1 to 5 B 7/1), dense; oyster fossils. At 49.0-49.5 feet, limestone is weathered and oxidized. At 53.0 feet, bluish gray (5 B 5/1) clay on auger bit teeth.

TOTAL DEPTH OF BOREHOLE: 53 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-24

LITHOLOGIC LOG OF SOIL BORING RSB-25; MONITOR WELL HM-112

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 25.0	GRAVELLY SILTY CLAY	CL	Light brown (5 YR 6/4), slightly plastic, moderately cohesive; gravel is subrounded, fine to medium grained whitish, matrix is very slightly damp.
25.0 - 27.0	GRAVEL	GP	Varicolored, medium to very coarse grained, subangular to subrounded, dry.
27.0 - 45.0	SILTY SAND - SANDY SILT	SM	Light brown (5 YR 5/6), very slightly cohesive, very slightly plastic, saturated; sand is very fine to fine grained, well rounded.
45.0 - 50.5	SANDY GRAVEL	GP	Varicolored, subrounded; sand is medium to very coarse grained, subrounded to subangular; gravel is fine to coarse grained, subangular to subrounded.
50.5 -50.75	FOSSILIFEROUS LIMESTONE	--	(N 4 to N 6), abundant shell fragments, hard.

TOTAL DEPTH OF BOREHOLE: 50.75 Feet

**Drilled by flight auger

*Unified Soil Classification System
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TABLE A-25

LITHOLOGIC LOG OF SOIL BORING RSB-26

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.5	CLAYEY SILT	ML	Moderate brown to grayish brown (5 YR 3/4 to 5 YR 3/2) slightly cohesive, nonplastic; moist .
			At 4.0-5.0 feet, trace gravel.
5.0 - 9.5	GRAVELLY SILT	GM	Light brown (5 YR 5/3) but calcification of soil horizons give a whitish appearance; gravel is fine- to coarse-grained limestone, minor cobbles, subangular to rounded; dry.
			At 5.0 feet, TIP reading is 1.5 ppm.
9.5 - 15.0	GRAVELLY SAND	GC	Light brown (5 YR 5/6) sand and gravel are very fine-grained; minor cobbles of subangular limestone; dry.
			At 15.0 feet, TIP reading is 350-400 ppm.
			At 20.0 feet, TIP reading is 115-120 ppm.
			At 25.0 feet, TIP reading is 20-25 ppm.
15.0 - 32.0	SILTY GRAVELLY SAND	GM	Light brown (5 YR 5/6) slightly cohesive, sand is very fine-grained; silt is slightly cohesive; gravel is fine- to medium-grained; subangular to well rounded; trace cobbles of subangular limestone.
			At 15.0-29.0 feet, moist.
			At 29.0-32.0 feet, saturated.

**Drilled by flight auger

*Unified Soil Classification System
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TABLE A-25 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-26

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
32.0	FOSSILIFEROUS LIMESTONE	--	Medium light gray to light gray (N 6 to N 7) dense, oyster fossils.

TOTAL DEPTH OF BOREHOLE: 32 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-26

LITHOLOGIC LOG OF SOIL BORING RSB-27

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 3	SILTY CLAY WITH GRAVEL	CL	Dark dusty red (10 R 2/2) very slightly damp, stiff, slightly cohesive, very slightly plastic; gravel approximately 5 percent, coarse-grained, subrounded.
3 - 19	CLAYEY SILT	ML	Light brown (5 YR 6/4) slightly damp, slightly cohesive, non-plastic.
19 - 21	GRAVELLY SANDY SILT	ML	Light brown (5 YR 5/6) sand is very fine to very coarse, varicolored, subangular; gravel is fine to medium, varicolored, subangular.
21 - 26.5	CLAYEY SILT	ML	Gray orange (10 YR 7/4) slightly damp, hard, moderately cohesive, slightly plastic.
26.5 - 29.5	SILTY SAND	SM	Light brown (5 YR 5/6) sand is very fine- to fine-grained, well rounded, very moist to saturated.
29.5	LIMESTONE	--	Yellow gray (5 Y 8/1) dense, minor fossils, dry (Goodland Formation).

TOTAL DEPTH OF BOREHOLE: 29.5 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-27

LITHOLOGIC LOG OF SOIL BORING RSB-28

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.5	SILTY CLAY WITH GRAVEL	CL	Dusty red (10 R 2/2) firm, very slightly damp, moderately plastic, moderately cohesive; gravel is very coarse-grained, subangular to subrounded.
2.5 - 29.5	CLAYEY SILT	ML	Light brown (5 YR 6/4) slightly damp, moderately cohesive, slightly plastic.
			Becoming damp at 25 feet bls.
29.5 - 31	SILTY SAND	SM	Light brown (5 YR 5/6) sand is very fine- to fine-grained, well rounded, very moist.
31 - 39.5	SILTY GRAVELLY SAND	SP	Varicolored, sand and gravel very fine- to very coarse-grained, subangular to subrounded with minor cobbles, saturated, loose.
			At 39.5 to 40.5 feet, clay layer.
40.5 - 45	SILTY SAND	SM	Yellow brown (5 YR 6/6) sand is fine- to medium-grained, well rounded, saturated, compact.
45 - 48.5	SANDY GRAVEL WITH COBBLES	GP	Varicolored, sand is fine- to very coarse-grained, subangular to subrounded; gravel is fine to very coarse, subangular to subrounded; cobbles are medium size, angular to subrounded, saturated, loose.
48.5 - 51.5	SILTY CLAY	CL	Gray orange (10 YR 7/4) dense, hard, very plastic, very cohesive.

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TABLE A-27 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-28

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
51.5 - 52	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 7) brittle angular shell fragments, Walnut Formation.

TOTAL DEPTH OF BOREHOLE: 52 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-28

LITHOLOGIC LOG OF SOIL BORING RSB-29; MONITOR WELL HM-113

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 30.0	SILTY CLAY, CLAYEY SILT	CL/ML	Light brown to medium brown (5 YR 5/6 to 5 YR 4/4), moderately cohesive, nonplastic, moist.
30.0 - 47.0	SILTY SAND	SM	Light brown (5 YR 5/6), sand is very fine-grained; silt is slightly cohesive; saturated.
47.0 - 49.0	GRAVELLY SAND	GP	No recovery from core barrel.
			At 49.0 feet, auger refusal.

TOTAL DEPTH OF BOREHOLE: 49 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-29

LITHOLOGIC LOG OF SOIL BORING RSB-30

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2	SILTY CLAY	CL	Dusty red (10 R 2/2) firm, dry, moderately cohesive, moderately plastic.
2 - 18.5	CLAYEY SILT	ML	Light brown (5 YR 6/4) dry, moderately cohesive, slightly plastic, stiff, becoming slightly damp at 15 feet bls.
18.5 - 28	SILTY SANDY GRAVEL	GP	Varicolored, sand is very fine to very coarse, gravel is fine to very coarse, angular to subanguler grains, 60 percent gravel, 30 percent sand, 10 percent silt; silt is light brown (5 YR 6/4) dry to slightly damp, becomes saturated at 26 feet bls.
28 - 29.5	SILTY SAND - SANDY SILT	SM	Light brown (5 YR 5/6) saturated, sand is very fine- to fine-grained, well rounded.
29.5 - 33	SILTY CLAY	SC	Pale red brown (10 R 5/4) hard, cohesive, plastic.
33 - 46	SANDY SILT	SM	Red orange (10 R 6/6) 80 percent silt, 20 percent sand; sand is very fine-grained, well rounded, saturated, soft, noncohesive, nonplastic.
46 - 50.5	SANDY GRAVEL	GP	Varicolored, shell fragments, subangular to subrounded, sand is medium-to very coarse-grained; gravel is fine- to very coarse-grained, loose, saturated. Approximately 75 percent gravel, 25 percent sand.

**Drilled by flight auger

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TABLE A-29 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-30

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
50.5 -50.75	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8) angular shell fragments, very hard, Walnut Formation.

TOTAL DEPTH OF BOREHOLE: 50.75 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-30

LITHOLOGIC LOG OF SOIL BORING RSB-31

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2	SILTY CLAY	CL	Dusty red (10 R 2/2) dry, moderately cohesive, moderately plastic.
2 - 5.5	LIMEY CLAY	CL	Very pale orange (10 YR 8/2) dense, hard, blocky, slightly damp.
5.5	LIMESTONE	--	Very pale orange (10 YR 8/2) dry, minor fossils, hard, Goodland Limestone.

TOTAL DEPTH OF BOREHOLE: 5.5 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-31

LITHOLOGIC LOG OF SOIL BORING RSB-32

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 5	GRAVELLY FILL	--	
5 - 9	SILTY CLAY WITH CONCRETE	CL	Dusty brown (5 YR 2/2) cohesive, moderately plastic.
9 - 10.5	ASPHALT AND CONCRETE	--	
10.5 - 14	CLAY	CL	Light olive gray (5 Y 5/2) moist, very cohesive, very plastic.
14 - 14.5	LIMESTONE	--	Pale orange (10 YR 8/2) dry, weathered, Goodland Limestone.

TOTAL DEPTH OF BOREHOLE: 14.5 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-32

LITHOLOGIC LOG OF SOIL BORING RSB-34

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.0	SILTY SAND	SM	Moderate reddish brown (10 YR 4/6) dry; sand is fine- to medium-grained; rounded.
1.0 - 3.0	GRAVELLY SAND	SP	Pale yellow brown (10 YR 6/2) white pebbles, cobbles and sandstone at 3.0 feet, reddish brown, silty sand lenses.
3.0 - 8.0	LIMESTONE	--	Very pale orange (10 YR 8/2) dry, friable in places, possible cobble.
8.0 - 10.0	CLAY WITH GRAVEL	CL	Moderate yellowish brown (10 YR 5/4) slightly cohesive, moderately plastic, angular to rounded cobbles, some sand, slightly moist.
10.0 - 13.0	SANDY CLAY	CL	Grayish orange (10 YR 7/4) medium to coarse sand, slightly cohesive) moderately plastic.
13.0 - 20.0	CLAY WITH GRAVEL	CL	Dusky yellowish brown (10 YR 2/2) slightly moist, moderately plastic with gravel cobbles, pebbles, miscellaneous debris, metal fragments, wire, ceramic, saturated at 18.0 feet, increasing sand and gravel at 17.0 feet, clay at 19.0-20.0, dark yellowish brown (10 YR 4/2).
20.0 - 23.0	GRAVEL WITH SILT AND CLAY	GC	Pale yellowish brown (10 YR 6/2) medium to coarse sand, varicolored, subangular.
26.5 - 27.0	CLAY	CL	Dark yellowish brown (10 YR 4/2) some gravel, plastic, moist, some roots.

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*Unified Soil Classification System
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TABLE A-32 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-34

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
27.0 - 28.0	GRAVEL	GW	Moderate yellowish brown (10 YR 5/4) cemented shells and shell fragments, angular to rounded, coarse sand, pebbles, cobbles; loo ·, varicolored, some clay.

TOTAL DEPTH OF BOREHOLE: 28.0 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-33

LITHOLOGIC LOG OF SOIL BORING RSB-35

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.5	CLAY	CL	Moderate brown (5 YR 3/4) roots, some coarse sand, slightly moist, moderately plastic.
0.5 - 1.0	GRAVELLY CLAY WITH SAND	CL	Grayish orange (10 YR 7/4) loose, dry.
1.0 - 3.5	LIMESTONE	--	Very pale orange (10 YR 8/2) dry, coarse fragments, friable in places, dry.
3.5 - 4.0	SANDY SILT WITH CLAY	ML	Grayish orange (10 YR 7/4) slightly moist, slighty plastic.
4.0 - 15.0	GRAVELLY CLAY	CL	Moderate brown (5 YR 4/4) increased gravel and sand at 10.0 feet, very coarse, loose gravel, dominantly limestone gravel, cobbles and pebbles, varicolored, coarse sand and gravel, loose, dry.
15.0 - 35.5	SAND WITH SILTY SAND	SM	Grayish orange (10 YR 7/4) to pale yellowish orange (10 YR 8/6) very uniform, medium sand, loose, dry to 22.5 feet, at 22.5 feet wet; from 23.5 to 24.0 feet clay lenses, 24.0 to 26.0 feet uniform sand, medium to coarse, 26.0 to 27.5 feet sand, coarse and uniform, 27.5 to 28.0 feet clay lenses, 28.0 to 32.0 feet medium uniform sand, 32.0 to 33.5 increasing grain size, coarse sand with gravel, varicolored pebble, shells, and shell fragments, loose.

TOTAL DEPTH OF BOREHOLE: 35.5 Feet

**Drilled by flight auger

*Unified Soil Classification System
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TABLE A-34

LITHOLOGIC LOG OF SOIL BORING RSB-36

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.1	CLAY	CL	Dusky yellowish brown (10 YR 2/2) moderately plastic, moderately cohesive, 10 percent gravel and coarse sand, rounded to subangular, up to one-half inch diameter, damp, roots.
1.0 - 1.5	LIMESTONE	--	Very pale orange (10 YR 8/2) cobble.
1.5 - 2.0	GRAVELLY CLAY	CL	Grayish orange (10 YR 7/4) moderately plastic, cohesive, 50 percent coarse-grained gravel and pebbles and coarse sand, subangular, dry.
2.0 - 10.0	GRAVELLY SAND	SW	Grayish orange to dark yellowish orange (10 YR 7/4 to 10 YR 6/6) 50 percent gravel to 50 percent sand, mediume to coarse sand, limestone gravel rounded to subangular, up to three-inch diameter, loose, dry.
10.0 - 12.0	SAND	SP	Dark yellowish orange (10 YR 6/6) uniform, coarse sand, wet.
12.0 - 15.0	GRAVELLY SAND	SW	Dark yellowish orange (10 YR 6/6).
15.0 - 16.0	SANDY GRAVEL	GP	Dark yellowish orange (10 YR 6/6) 50 to 60 percent coarse gravel, 40 to 50 percent coarse sand, rounded to subangular, cobbles, pebbles, predominantly limestone shells.
16.0 - 17.0	CLAY	CL	Moderate yellowish brown (10 YR 5/4) plastic, cohesive, mottled coloring rust and green, contact with clay is variable, light and dark colored clay.

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*Unified Soil Classification System
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TABLE A-34 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-36

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
17.0 - 17.5	CLAY	CL	Dusky yellowish brown (10 YR 2/2), very plastic, cohesive, slightly moist.
17.5 - 18.0	SHALE	--	Medium gray (N6 to N5), slightly friable, fissile.

TOTAL DEPTH OF BOREHOLE: 18.0 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-35

LITHOLOGIC LOG OF SOIL BORING RSB-37

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.1	CLAY	CL	Dark yellowish brown (10 YR 4/2) plastic, poorly cohesive, some white gravel, 10 to 20 percent, dry.
1.0 - 3.0	GRAVELLY CLAY	CL	Moderate yellowish brown (10 YR 5/4) plastic, poorly cohesive, greater than 50 percent coarse gravel and sand, rounded to subrounded, poorly sorted, dry.
3.0 - 3.5	SAND WITH SILT	SM	Grayish orange (10 YR 7/4) fine- to medium-grained sand, loose, dry, some limestone cobbles.
3.5 - 7.0	GRAVELLY SANDY CLAY	CL	Moderate brown (5 YR 3/4) 30 percent clay; 20 percent sand; 50 percent gravel, rounded to subrounded pebbles, white, pink, and varicolored, dry.
7.0 - 8.5	CLAY	CL	Dark yellowish brown (10 YR 4/2) moderately plastic, noncohesive, dry.
8.5 - 13.0	CLAY TO GRAVELLY CLAY	CL	Olive gray (5Y 4/1) with mottled white, dark yellowish orange (and gray streaks, 50 percent clay; 40 percent gravel; 10 percent sand, limestone pebbles, dry.
13.0 - 20.0	CLAY	CL	Grayish orange (10 YR 7/4) and pale yellowish brown (10 YR 6/2) very dry, nonplastic, noncohesive, slightly fissile, blocky.

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TABLE A-35 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-37

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
20.0 - 20.5	SHALE	--	Medium light gray (N6 to N5) dense, fissile, dry.

TOTAL DEPTH OF BOREHOLE: 20.5 Feet

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**Drilled by flight auger

TABLE A-36

LITHOLOGIC LOG OF SOIL BORING RSB-38

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.1	CLAY	CL	Dark yellowish brown (10 YR 4/2) moderately plastic, poorly cohesive, some white gravel, 10 to 20 percent, dry.
1.0 - 4.0	GRAVELLY CLAY	CL	Very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) cohesive, dense clay to loose silty sand with rounded to subrounded cobbles, pebbles, coarse sand, poorly sorted, dry.
4.0 - 6.0	SILTY SAND WITH GRAVEL	SW	Moderate brown (5 YR 4/4) 30 percent gravel; 60 to 70 percent sand; 0 to 10 percent fines, rounded to subrounded, pebbles, coarse sand, limestone, gravel.
6.0 - 18.0	GRAVELLY CLAY	CL	Moderate brown (5 YR 4/4) grading to moderate yellowish brown (10 YR 5/4) to pale yellowish brown (10 YR 6/2) very plastic, dense, 50 to 70 percent gravel, 50 to 30 percent clay, poorly sorted, pebbles, sand, cobbles, rounded to subangular, clay dusky yellowish brown (10 YR 2/2) at 10.0 to 11.0 feet interbedded dense clay with gravelly clay.
18.0 - 23.0	CLAY	CL	Dusky yellowish brown (10 YR 2/2) moderately plastic, noncohesive, slightly moist, less than 20 percent gravel.
23.0 - 28.0	GRAVELLY CLAY WITH SAND LENSES	CL/SC	Dark yellowish brown (10 YR 4/2) plastic, noncohesive, 50 to 70 percent gravel, 50 to 30 percent clay, limestone cobble 4 inches in diameter, subrounded.

**Drilled by flight auger

*Unified Soil Classification System
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TABLE A-36 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-38

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
28.0 - 41.5	SAND	SP	Moderate yellowish brown (10 YR 5/4) uniform, fine to medium sand with 10 percent silt, increasing grain size with depth, medium- to coarse-grained sand, 10 to 20 percent fine gravel.
41.5 - 42.0	LIMESTONE	--	Cemented shell fragment.

TOTAL DEPTH OF BOREHOLE: 42.0 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-37

LITHOLOGIC LOG OF SOIL BORING RSB-39

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.0	GRAVELLY CLAY	CL	Dusky yellowish brown (10 YR 2/2) moderately plastic, noncohesive, 30 to 50 percent gravel, subrounded pebbles, cobbles, sand, roots, dry.
2.0 - 6.5	CLAY WITH SILT	ML	Dusky yellowish brown (10 YR 2/2) moderately plastic, noncohesive, "earthy", dry, increasing silt with depth.
6.5 - 9.0	SANDY SILT WITH GRAVEL	SM	Pale yellowish brown (10 YR 6/2) 10 to 20 percent gravel; 30 percent sand; 50 percent silt, fine sand, poorly sorted, slightly cemented, friable, dry, subrounded, some coatings on grains.
9.0 - 16.0	SILTY SAND WITH CLAY AND GRAVEL	SM/SC	Moderate yellowish brown (10 YR 5/4) 50 percent fine sand; 20 percent silt; 30 percent clay, minor gravel, dry, some coatings on grains, increasing sand with depth, variable clay lenses interbedded, gravel 10 to 40 percent, increasing with depth, dry, loose.
16.0 - 33.0	SILTY SAND	SM	Light brown (5 YR 5/6) uniform fine sand, 30 percent silt, increasing grain size. At 30 feet, less silt, wet.

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-37 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-39

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
33.0 -40.0	GRAVEL	GP	Light brown (5 YR 5/6) 50 percent gravel; 30 percent sand; 20 percent silt and clay, poorly sorted, subrounded to angular, 50 percent very coarse sand. Thirty-eight to 40 feet, little recovered, loose gravel, clean wet, subrounded to angular, moderately sorted, fines lost.

TOTAL DEPTH OF BOREHOLE: 40.0 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-38

LITHOLOGIC LOG OF SOIL BORING RSB-40

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.0	CLAY	CL	Moderate brown (5 YR 3/4) moderately plastic, noncohesive, some gravel, 10 to 20 percent gravel, pebbles, roots, dry.
2.0 - 15.0	SILTY SAND WITH CLAY AND GRAVEL	SM	Grayish orange (10 YR 7/4) with moderate brown (5 YR 4/4) clay interbedded, poorly sorted, variable gravel, 10 to 40 percent, fine- to medium-grained sand, subrounded to subangular pebbles, cobbles, some limestone pebbles and cobbles, lime fill material. At 4.0 feet, color is moderate brown (5 YR 4/4). At 5.0 to 6.0 feet, dusky yellowish brown (10 YR 2/2) clay with silt.
15.0 - 16.0	GRAVELLY CLAY	CL	Medium light gray (N6-N5) plastic, 20 percent poorly sorted gravel, wet.
16.0 - 24.0	GRAVEL WITH SAND AND CLAY	GM	Dark yellowish brown (10 YR 4/2) poorly sorted, subrounded to angular gravel, miscellaneous debris, wood 1-1/2 inch diameter branch.
24.0 - 28.0	SAND	SP	Pale yellowish brown (10 YR 6/2) uniform medium to coarse sand, with interbedded fine gravel.
27.0 - 28.0	LIMESTONE	--	Dark yellowish orange (10 YR 6/6) weathered, dense limestone, fragments with clay.

TOTAL DEPTH OF BOREHOLE: 28.0 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-39

LITHOLOGIC LOG OF SOIL BORING RSB-41

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.0	SANDY SILT WITH GRAVEL AND CLAY	ML	Moderate red brown (5 YR 4/4) 20 percent gravel; 40 percent sand and silt; 30 percent clay, roots, dry, limestone cobble, poorly sorted, subrounded to angular gravel.
2.0 - 4.0	NO RECOVERY		
4.0 - 5.0	SILTY CLAY	CL	Dusky yellowish brown (10 YR 2/2) plastic, noncohesive, dry.
5.0 - 9.0	GRAVELLY SAND WITH SILT AND CLAY	SC	Very pale orange (10 YR 8/2) 20 to 30 percent gravel, limestone cobbles up to 4 inches in diameter, subrounded to subangular, poorly sorted, some loose, dry.
9.0 - 12.0	GRAVELLY CLAY	CL	Varicolored, grayish orange (10 YR 7/4) plastic, noncohesive, 10 percent gravel, cobbles to very coarse sand, subrounded to subangular, slightly moist.
12.0 - 18.5	CLAY WITH GRAVEL	CL	Pale yellowish brown (10 YR 6/2) from 12.0 to 13.0 feet, dusky brown (5 YR 2/2). At 13 to 16 feet, plastic, noncohesive, slightly moist, moderate yellowish brown (10 YR 5/4). At 16.0 to 18.5 feet, less than 10 percent gravel.

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-39 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-41

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
18.5 - 26.0	GRAVELLY SAND WITH CLAY	SC	Moderate yellowish brown (10 YR 5/4) 30 percent gravel; 50 percent sand; 20 percent clay and silt, poorly sorted, subrounded to subangular, pebbles, cobbles, coarse sand, loose, slightly moist, limestone gravel shells.
26.0 - 38.0	GRAVELLY SAND	GW	Dark yellowish orange (10 YR 6/6) variable percentage gravel with uniform medium- to coarse-grained sand, shells, loose, wet.
37.5 - 38.0	LIMESTONE	--	Moderate yellowish brown (10 YR 5/4) weathered, shells in limestone.

TOTAL DEPTH OF BOREHOLE: 38.0 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-40

LITHOLOGIC LOG OF SOIL BORING RSB-42

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.0	CLAY	CL	No description.
1.0 - 4.0	GRAVELLY SAND	SW	White, pale orange, limestone gravel.
4.0 - 15.0	SANDY GRAVEL WITH CLAY	GC	No color, poorly sorted, subangular to subrounded, gravelly clay at 4.0 to 6.0 feet, loose, dry.
15.0 - 35.5	SAND	SP	Uniform, medium sand, increasing grain size at 32.0 feet. At 23 feet, wet.

TOTAL DEPTH OF BOREHOLE: 35.0 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-41

LITHOLOGIC LOG OF SOIL BORING RSB-43

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 4.0	CLAY	CL	Dark yellowish brown (10 YR 4/2) plastic, uniform, "earthy", noncohesive, dry.
4.0 - 7.0	CLAY	CL	Moderate yellowish brown (10 YR 6/6) similar to 0 to 4.0 feet clay, dry.
7.0 - 11.0	GRAVELLY CLAY WITH SAND	CL	Light brown (5 YR 5/6) 50 percent gravel; 10 to 20 percent sand; 30 to 40 percent clay, plastic, subrounded cobbles, pebbles, coarse sand, poorly sorted, limestone gravel.
11.0 - 30.0	GRAVELLY SAND	SW	Light brown (5 YR 5/6) similar composition as interval from 7.0 to 11.0 feet, increasing sand, decreasing clay, 30 percent gravel; 70 percent sand, trace silt, medium sand, loose, dry at 19.0 feet; 14.0 to 19.0 feet all loose sand and gravel; 19.0 feet to 24.0 feet no recovery; 24.0 to 29.0 feet wet loose sand and gravel, poorly sorted gravel, subrounded, wet limestone and varicolored material, pebbles, coarse sand, some cobbles.
30.0 - 33.0	SAND	SP	Pale yellowish brown (10 YR 6/2) uniform, fine sand, some silt, wet.
33.0 - 33.5	LIMESTONE	--	Dark yellowish orange weathered shells and clay, poorly cemented, weathered.

TOTAL DEPTH OF BOREHOLE: 33.5 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-42

LITHOLOGIC LOG OF SOIL BORING RSB-44

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.0	CLAY	CL	Dusky yellowish brown (10 YR 2/2) plastic, noncohesive, dry, roots.
1.0 - 2.0	CLAY WITH GRAVEL	CL	Moderate brown (5 YR 4/4) 10 percent gravel, medium pebbles, subrounded, plastic clay, dry.
2.0 - 11.0	CLAY	CL	Dusky yellowish brown (10 YR 2/2) plastic, noncohesive, dry, color change from 9.0 to 10.0 feet, dark yellowish brown (10 YR 4/2).
11.0 - 16.0	SAND WITH CLAY	SC	Pale yellowish brown (10 YR 6/2) with dark yellowish orange (10 YR 6/6) mottled color, fine sand, 10 percent clay, decreasing with depth.
16.0 - 26.5	SAND	SP	Dark yellowish orange (10 YR 6/6) uniform, fine to medium sand, some silt, dry from 16.0 to 20.0 feet, wet at 20.0 feet, increasing grain size at 20.0 feet, coarse sand and gravel, discolored rust from 24.0 to 26.0 feet.
26.5 - 27.0	LIMESTONE	--	Grayish orange (10 YR 7/4) dense, slightly friable.

TOTAL DEPTH OF BOREHOLE: 27.0 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-43

LITHOLOGIC LOG OF SOIL BORING RSB-45

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.5	GRAVELLY CLAY	CL	Light brown (5 YR 5/6) 20 percent gravel consisting of pebbles, coarse sand, plastic, noncohesive, slightly moist, subrounded gravel.
2.5 - 9.0	GRAVELLY SAND WITH CLAY	GC	Grayish orange (10 YR 7/4) variable percent gravel, sand, clay, pebbles, coarse sand, 10 to 20 percent, fine- to medium-grained 40 to 50 percent, interbedded clayey units, loose, dry, clayey units compacted, mottled colored rust and gray.
9.0 - 14.0	SILTY CLAY WITH SAND	ML	Light brown (5 YR 5/6) with very pale orange (powdery discoloring, 60 percent clay; 40 percent sand and silt, plastic, noncohesive, slightly moist.
14.0 - 21.0	SAND	SP	Light brown (5 YR 5/6) uniform, fine, increased grain size medium to coarse at 21.0 feet, slightly moist, loose.
21.0 - 30.0	SAND WITH GRAVEL	SW	Pale yellowish brown (10 YR 6/2) 20 percent gravel; 70 percent sand; 10 percent fine, subangular to subrounded, loose, dry 21.0 to 25.0 feet, wet 25.0 to 31.0 feet, cobbles up to 3 inches in diameter.
30.0 - 31.0	LIMESTONE	--	Light olive gray (5Y 5/2) plastic, noncohesive shaley limestone, fissile to dense, dense clay at contact.

TOTAL DEPTH OF BOREHOLE: 31.0 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-44

LITHOLOGIC LOG OF SOIL BORING RSB-46

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.0	SILTY SAND WITH GRAVEL	SM	Dusky yellowish brown (10 YR 2/2) 20 percent gravel; 80 percent sand and silt, subrounded to subangular, pebbles, fine sand, loose, dry to slightly moist.
1.0 - 5.0	SILTY CLAY WITH GRAVEL	CL	Moderate yellowish brown (10 YR 5/4) with white coatings on pebbles, less than 10 percent gravel, 50 percent clay; 40 percent silt, slightly plastic, noncohesive, slightly moist. At 4.0 to 5.0 feet, interbedded medium sand.
5.0 - 24.0	CLAY	CL	Light brown (5 YR 5/6) plastic, noncohesive, mottled pale yellowish brown (10 YR 6/2) slightly moist, crumbled to plates in places.
24.0 - 38.0	SAND	SP	Light brown (5 YR 5/6) uniform, fine sand, wet, increased grain size from 36.0 to 38.0 feet to medium sand, increasing grain size and gravel at 38.0 feet.
38.0 - 40.5	SANDY GRAVEL	GW	No description.

TOTAL DEPTH OF BOREHOLE: 40.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-45

LITHOLOGIC LOG OF SOIL BORING RSB-47

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.5	CLAY	CL	Grayish brown (5 YR 3/2) plastic, noncohesive, slightly moist to dry.
2.5 - 11.0	GRAVELLY CLAY WITH SAND	CL	Light brown (5 YR 5/6) 10 to 20 percent gravel; 10 to 20 percent sand; 60 to 80 percent clay, subrounded pebbles, fine- to medium-grained sand, dry, loose to dense, decreasing gravel and sand to predominantly clay at 4.0 feet, white coatings on pebbles throughout.
11.0 - 15.0	SANDY CLAY	ML	Light brown, 20 to 30 percent (5 YR 5/6) plastic, noncohesive, fine to medium sand, dry.
15.0 - 19.0	SAND WITH SILT	SM	Light brown (5 YR 5/6) uniform fine- to medium-grained sand, loose, slightly moist, 80 percent sand; 20 percent silt.
19.0 - 28.0	SAND	SP	Light brown (5 YR 5/6) uniform, fine to medium, to coarse, loose, wet at 20.0 feet.
28.0 - 37.5	GRAVEL WITH SAND, SOME CLAY	GM	Grayish orange (10 YR 2/4) 50 to 70 percent gravel; 10 to 20 percent sand; less than 10 percent clay. At 33.0 feet slight odor; 34.0 to 35.0 feet coarse sand lenses, increasing grain size at 37.5 feet, well-sorted, subrounded to rounded pebbles, shells.

TOTAL DEPTH OF BOREHOLE: 37.5 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-46

LITHOLOGIC LOG OF SOIL BORING RSB-48

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.5	SILTY CLAY	CL	Dark brown (5 YR 2/2) very plastic, cohesive, uniform.
1.5 - 4.0	SANDY SILT	ML	Dark brown to moderate brown (5 YR 3/4) slightly plastic, slightly cohesive, uniform, slightly moist to dry.
4.0 - 9.0	GRAVELLY CLAY	CL	Moderate brown (5 YR 4/4) poor plasticity, noncohesive, poorly sorted gravel, subangular to subrounded, slightly moist.
9.0 - 14.5	SAND	SP	Dark yellowish orange (10 YR 6/6) loose, uniform, fine to coarse, dry.
14.5 - 15.0	LIMESTONE	--	Gray weathered with clay, fissile, dry.

TOTAL DEPTH OF BOREHOLE: 15.0 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-47

LITHOLOGIC LOG OF SOIL BORING RSB-49

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.0	CLAY	CL	Dusky yellowish brown (10 YR 2/2).
1.0 - 3.0	SANDY SILT WITH CLAY	ML	Moderate brown (5 YR 4/4).
3.0 - 4.0	SANDY SILT	ML	Moderate brown (5 YR 3/4).
4.0 - 13.0	GRAVELLY SAND WITH CLAY	SW	Pale yellowish brown (10 YR 6/2) and sandy clay.
13.0 - 16.5	LIMESTONE	--	Dense, shaley, dry.

TOTAL DEPTH OF BOREHOLE: 16.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-48

LITHOLOGIC LOG OF SOIL BORING RSB-50

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.5	CLAY WITH SOME SILT	CL	Dark brown (5 YR 2/2) very plastic, moderately cohesive, slightly moist to moist.
0.5 - 1.0	SILTY CLAY	CL	Moderate brown (5 YR 4/4) moderately plastic, moderately to poorly cohesive, slightly moist.
1.0 - 6.0	GRAVELLY CLAY	CL	Light brown (5 YR 5/6) to moderate reddish brown (10R 4/6) moderately plastic, moderately cohesive, slightly moist, gravel well-sorted, subangular.
6.0 - 7.0	CLAYEY SAND	SC	Light brown (5 YR 5/6) low plasticity, poorly cohesive, slightly moist, well-sorted sand, subrounded.
7.0 - 11.0	SAND	SP	Light brown (5 YR 5/6) loose, subrounded to very fine to fine sand, slightly moist to dry.
11.0 - 20.5	SANDY GRAVEL	SW	Pale yellowish orange (10 YR 8/6) loose, poorly sorted, well-rounded to angular, 20 percent gravel poorly sorted; 80 percent sand poorly sorted.
20.5 - 21.0	CLAY	CL	Mostly yellowish gray (5 Y 7/2) with pale olive (10 Y 6/2) and dusky yellow, (5 Y 6/4) streaks, fairly plastic, slightly cohesive.

TOTAL DEPTH OF BOREHOLE: 21.0 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-49

LITHOLOGIC LOG OF SOIL BORING RSB-51

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.0	GRAVELLY, SANDY CLAY	CL	Moderate brown (5 YR 5/6) 10 percent gravel; 10 to 20 percent sand; 70 to 80 percent clay, plastic, noncohesive, poorly sorted sand, moist, dense.
2.0 - 7.0	GRAVELLY CLAY	CL	Varicolored, moderate yellowish brown (10 YR 5/4) grayish orange (10 YR 7/4) pale yellowish brown (10 YR 6/2) plastic, 20 to 30 percent gravel, slightly moist, poorly sorted, subrounded to subangular pebbles, some cobbles, limestone, loose.
7.0 - 8.0	SAND WITH SILT	SM	Moderate yellowish brown (10 YR 5/4) 80 percent fine sand; 20 percent silt, uniform, slightly moist.
8.0 - 13.0	GRAVELLY CLAY	CL	Varicolored, same as from 2.0 to 7.0 feet, slightly moist, loose.
13.0 - 28.0	SAND	SP	Light brown (5 YR 6/4) uniform, fine to medium sand, moist from 13.0 to 19.0 feet, loose, wet from 19.0 to 28.0 feet, sand, slurry.
28.0 - 28.5	LIMESTONE	--	Dark yellowish with very pale orange (10 YR 8/2) shells, cemented, weathered in places, clayey, limey layers, 1.8-inch thick, oysters.

TOTAL DEPTH OF BOREHOLE: 28.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-50

LITHOLOGIC LOG OF SOIL BORING RSB-52

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.0	CLAY	CL	Dark yellowish brown (10 YR 4/2) plastic, some gravel, roots, dense, moist.
1.0 - 4.0	SILTY SAND	SM	Varicolored, moderate brown (5 YR 4/4) moderate yellowish brown (10 YR 5/4) dark yellowish brown (10 YR 4/2) 60 percent sand; 30 percent silt; 10 percent clay, variable clay interbedded, fine sand, loose, slightly moist.
4.0 - 5.0	CLAY WITH SILT	ML	Dark yellowish brown (10 YR 4/2) mottled pale yellowish brown, (10 YR 6/2) plastic, noncohesive clay lenses.
5.0 - 9.0	SAND WITH SILT AND CLAY	SC	Grayish orange (10 YR 7/4) increasing sand with depth, fine to medium sand, slightly moist, loose.
9.0 - 12.0	SAND WITH GRAVEL	SW	Moderate brown (5 YR 4/4) 60 percent sand; 40 percent gravel, coarse sand, subrounded to subangular, pebbles, some cobbles, discolored at 11.0 feet, dark yellowish orange (10 YR 6/6).
12.0 - 17.5	CLAY	CL	Yellowish gray (5 Y 7/2) with pale olive (10 Y 6/2) and dusky yellow (5 Y 6/4) streaks, plastic, slightly cohesive, medium light gray to medium gray (N 5 to N 6) at 14 feet.
17.5 - 18.0	LIMESTONE	--	Dusky yellow (5 Y 6/4), dense, platey sandy.

TOTAL DEPTH OF BOREHOLE: 18.0 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-51

LITHOLOGIC LOG OF SOIL BORING RSB-53

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.0	CLAY WITH GRAVEL	CL	Moderate brown (5 YR 3/4) plastic, noncohesive, 10 to 20 percent small pebbles, roots, dense, slightly moist.
2.0 - 4.0	SILT	ML	Dark yellowish brown (10 YR 4/2) loose, dry.
4.0 - 13.0	CLAY WITH SILT	CL	Dark yellowish brown (10 YR 4/2) plastic, noncohesive, from 9.0 to 13.0 feet pale yellowish brown (10 YR 6/2) with interbedded rust-stained stringers.
13.0 - 23.0	SAND	SP	Pale yellow brown (10 YR 6/2) uniform, medium sand, color change at 19.0 feet to moderate yellowish brown (10 YR 5/4) loose, wet.
23.0 - 23.5	LIMESTONE	--	Grayish orange (10 YR 7/4) with shale, dense, weathered to plates.

TOTAL DEPTH OF BOREHOLE: 23.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-52

LITHOLOGIC LOG OF SOIL BORING RSB-54

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 4.0	CLAY	CL	Dusky yellowish brown (10 YR 2/2) plastic, slightly cohesive, dense, slightly moist.
4.0 - 8.0	GRAVELLY CLAY	CL	Varicolored (10 YR 7/4, 6/6, 5/4) 50 percent gravel; 50 percent clay, poorly sorted, angular to subrounded, limestone fragments, "earthy", friable, coatings on pebbles.
8.0 - 9.0	SILTY CLAY	CL	Dark yellowish orange (10 YR 6/6) plastic, noncohesive, dense, slightly moist.
9.0 - 15.0	SILTY SANDY CLAY	CL	Dark yellowish orange (10 YR 6/6) 40 percent sand and fines; 60 percent clay, increased sand with depth, fine sand, slightly moist.
15.0 - 19.0	SANDY GRAVELLY CLAY	CL	Dark yellowish orange (10 YR 6/6) 30 percent gravel; 20 percent sand; 50 percent clay, moist, poorly sorted, angular to subrounded. At 17 to 19 feet, increased sand.
19.0 - 24.0	GRAVEL WITH SAND AND CLAY	GC	Dark yellowish orange (10 YR 6/6) 70 percent gravel; 30 percent sand and clay, moderately sorted, subangular to subrounded, wet, loose.
20.0 - 24.5	LIMESTONE	--	Very pale orange (10 YR 8/2) platey, friable, dry.

TOTAL DEPTH OF BOREHOLE: 24.5 Feet

**Drilled by flight auger

*Unified Soil Classification System
ASTM D-2487

TABLE A-53

LITHOLOGIC LOG OF SOIL BORING RSB-55

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 2.0	CLAY	CL	Dark yellowish brown (10 YR 4/2) plastic, noncohesive, dense, roots, slightly moist.
2.0 - 4.0	GRAVELLY SANDY CLAY	CL	Moderate yellowish brown (10 YR 5/4).
4.0 - 8.0	CLAY	CL	Dark yellowish orange (10 YR 6/6) with mottled, white, chalky coatings on the pebbles, dry, dense.
8.0 - 15.0	SAND WITH SILT	SM	Light brown (5 YR 5/6) 70 percent sand; 30 percent silt, fine sand, slightly moist, loose.
15.0 - 27.0	SAND WITH GRAVEL	SW	Very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) very coarse sand, small pebbles, shells, loose, dry to 20.0 feet, variable 40 to 60 percent gravel, increased clay at 23.0 to 24.0 feet.
27.0 - 29.0	CLAY	CL	Yellowish gray (5 Y 7/2) with pale olive (10 Y 6/2) and dusky yellow (5 Y 6/4) streaks, plastic, slightly cohesive.
29.0 - 30.0	LIMEY CLAY	CL	Medium dark gray (N 5 to N 4) plastic, dense, platey with grayish olive (10 YR 4/2) lenses.

TOTAL DEPTH OF BOREHOLE: 30.0 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-54

LITHOLOGIC LOG OF SOIL BORING RSB-56

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.5	SILTY CLAY WITH SOME GRAVEL	CL	Grayish brown (5 YR 3/2) slightly plastic, noncohesive, 10 percent gravel; 40 percent silt; 50 percent clay, gravel up to 1 inch in diameter, subangular limestone, moist.
0.5 - 1.0	CLAYEY GRAVEL WITH SOME SAND	GC	Dark yellowish orange (10 YR 6/6) clay, slightly plastic to noncohesive, 80 percent gravel; 15 percent clay; 5 percent sand, gravel 1/4 to 1 inch diameter, subangular limestone, slightly moist.
1.0 - 1.5	SILTY SAND	SM	Moderate brown (5 YR 3/4) very fine sand, subangular, slighly moist.
1.5 - 2.0	SAND	SP	Dark yellowish brown (10 YR 4/2) very fine, subangular, slightly moist.
2.0 - 9.0	GRAVELLY CLAY WITH SOME SAND	CL	Dark yellowish orange (10 YR 6/6) with white limestone gravel, slightly plastic, noncohesive, 1/2 to 1 1/2 inch diameter limestone gravel, subrounded to rounded, very fine grains, subangular sand, 60 percent clay; 30 gravel; 10 percent sand. At 4 to 9 feet, increasing clay, smaller gravel, more white limestone.

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE A-54 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-56

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
9.0 - 20.0	CLAY	CL	Dark yellowish orange (10 YR 6/6) slightly plastic, slightly cohesive, slightly moist.
			At 14 to 20 feet, increasing mottled gray clay.
20.0 - 21.0	SAND	SP	Light brown (5 YR 5/6) very fine-grained, subangular to angular, slightly moist.
21.0 - 41.0	SAND	SP	Grayish orange (10 YR 7/4) very moist, well sorted, medium to very coarse, from 34.0 to 39.0 feet, wet.
41.0 - 42.5	CLAYEY GRAVEL	GC	No description.

TOTAL DEPTH OF BOREHOLE: 42.5 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-55

LITHOLOGIC LOG OF SOIL BORING RSB-57

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.1	SILTY SANDY CLAY WITH SOME GRAVEL	CL	Dark yellowish brown (10 YR 4/2) plastic, slightly cohesive, moist, sand and gravel limestone fragments, subangular.
1.0 - 1.5	CLAY	CL	Yellowish gray (5Y 7/2) nonplastic, noncohesive, moist, mottled with dark brown clay balls.
1.5 - 2.0	GRAVELLY SANDY CLAY	CL	Mottled dark yellowish brown (10 YR 4/2) with dark yellowish orange (10 YR 6/6) 35 percent gravel; 10 percent sand; 55 percent clay, nonplastic, noncohesive, slightly moist.
2.0 - 3.0	CLAY	CL	Yellowish gray (5Y 7/2) nonplastic, noncohesive, moist, mottled with dark brown clay balls.
3.0 - 4.0	SILTY CLAY/ CLAYEY SILT WITH SOME GRAVEL	CL/ML	Light brown (5 YR 5/6) slightly plastic, noncohesive, slightly moist, less than 5 percent gravel.
4.0 - 6.0	SILTY CLAY/ CLAYEY SILT WITH SOME GRAVEL	CL/ML	Light brown (5 YR 5/6) gravel increases to 20 percent, gravel composed of limestone, 1/4 inch in diameter, subrounded.
6.0 - 10.5	SILTY SANDY GRAVEL	GC/SM	Very pale orange (10 YR 8/2) gravel 1/4 inch to 1 1/4 inch in diameter, limestone, subangular to subrounded, 50 percent gravel; 25 percent silt; 20 percent sand; 5 percent fines, slightly moist to dry.

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TABLE A-55 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-57

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
10.5 - 15.5	CLAYEY GRAVEL WITH SOME SAND	GC	Light brown (5 YR 5/6) nonplastic, noncohesive, slightly moist, gravel limestone, 1/4 inch to 1 inch in diameter, subrounded.
15.5 - 19.0	CLAY	CL	Yellowish gray (5 Y 7/2) with pale olive (10 Y 6/2) and dusky yellow (5 Y 6/4) streaks, plastic, slightly cohesive, slightly moist.
19.0 - 20.0	LIMESTONE	--	Yellowish gray (5 Y 8/1) platey, dry.

TOTAL DEPTH OF BOREHOLE: 20.0 Feet

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TABLE A-56

LITHOLOGIC LOG OF SOIL BORING RSB-58

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.0	CLAY	CL	Dark yellowish brown (10 YR 4/2) plastic, noncohesive, slightly moist, 10 to 20 percent gravel, pebbles and coarse sand, subrounded.
1.0 - 4.0	GRAVELLY CLAY	CL	Grayish orange (10 YR 7/4) 20 percent gravel; 10 percent sand; 70 percent clay, plastic, noncohesive, dry, some loose, some dense, subangular to subrounded.
4.0 - 18.0	GRAVELLY CLAY WITH SAND	CL	Moderate yellowish brown (10 YR 5/4) from 4.0 to 14.0 feet, light brown (5 YR 5/6) from 14.0 to 18.0 feet, plastic, noncohesive, 10 to 30 percent gravel; 20 to 30 percent sand; 70 to 40 percent clay, increased sand and gravel with depth, slightly moist, dense, poorly sorted, subrounded to subangular.
18.0 - 30.0	CLAYEY SANDY GRAVEL	GC/SC	Grayish orange (10 YR 7/4) increased grain size, pebbles and cobbles, poorly sorted, weathered gravel, subangular to subrounded, slightly moist, limestone fragments. At 30 to 35 feet, wet.
35.0 - 35.5	GRAVELLY CLAY	CL	Yellowish gray (5Y 7/2) slightly moist.
35.5 - 36.0	LIMESTONE	--	Weathered shelly limestone, oysters.

TOTAL DEPTH OF BOREHOLE: 36.0 Feet

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TABLE A-57

LITHOLOGIC LOG OF SOIL BORING RSB-59

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.0	CLAY	CL	Dark yellowish brown (10 YR 4/2) plastic, noncohesive, roots, slightly moist.
1.0 - 2.0	GRAVELLY CLAY	CL	Grayish orange (10 YR 7/4) poorly sorted, weathered cobbles, shale, (pale olive), plastic, noncohesive, slightly moist.
2.0 - 4.0	GRAVELLY CLAY	CL	Dark yellowish brown (10 YR 4/2) 20 to 40 percent gravel, subangular to subrounded pebbles, cobbles, coarse sand, slightly moist.
4.0 - 8.0	GRAVELLY CLAY	CL	Dusky yellowish brown (10 YR 2/2) less gravel than from 2.0 to 4.0 feet, plastic, noncohesive, slightly moist, mottled light brown (5 Y 5/6) from 7.0 to 8.0 feet.
8.0 - 14.0	SILTY CLAY WITH GRAVEL	CL	Dusky yellowish brown (10 YR 2/2) 10 percent gravel, coarse sand, few pebbles, plastic, noncohesive, slightly moist, at 12.0 feet, color changes to moderate yellowish brown (10 YR 5/4).
14.0 - 18.0	GRAVEL WITH SAND AND CLAY	GC	Grayish orange (10 YR 7/4) 50 percent gravel; 20 percent sand; 30 percent clay, subrounded to subangular, loose, slightly moist.
18.0 - 29.0	SAND	SP	Dark yellowish orange (10 YR 6/6) uniform, fine sand from 18.0 to 22.0 feet, medium to coarse sand from 22.0 to 29.0 feet.

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TABLE A-57 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-59

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
29.0 - 31.0	GRAVEL WITH SAND	GW	Grayish orange (10 YR 7/4) increasing grain size with depth, limestone at 31.0 feet, cemented shells, rounded to subangular to subrounded cobbles up to 3 inches in diameter.

TOTAL DEPTH OF BOREHOLE: 31.0 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE A-58

LITHOLOGIC LOG OF SOIL BORING RSB-60

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 1.5	SILTY SANDY CLAY WITH GRAVEL	CL	Dusky yellowish brown (10 YR 2/2) nonplastic, noncohesive, very moist to wet. At 0.5 to 1 foot, plastic. At 1 to 1.5 feet, dark yellowish orange (10 YR 6/6).
1.5 - 6.5	SILTY CLAY WITH SOME SAND	CL	Dusky yellowish brown (10 YR 2/2) plastic, noncohesive, moist.
6.5 - 11.0	SILTY CLAY	CL	Mottled colors, medium gray (N 5) and dark yellowish orange (10 YR 6/6) slightly plastic, noncohesive, slightly moist, from 6.5 to 9.0. At 9 to 11 feet, 40 percent weathered limestone fragments, 3/4 inch in diameter.
11.0 - 19.0	GRAVELLY CLAY WITH SILT AND SAND	CL	Very light gray (N 8) slightly plastic, slightly cohesive, gravel 1/4 to 2 inches in diameter, slightly moist. At 14 to 19 feet, dark yellowish (10 YR 6/6).
19.0 - 21.0	LIMESTONE	--	Very light gray (N 8) shaley.

TOTAL DEPTH OF BOREHOLE: 21.0 Feet

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**Drilled by flight auger

TABLE A-59

LITHOLOGIC LOG OF SOIL BORING RSB-61

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.5	CLAYEY SILT WITH SOME SAND AND GRAVEL	ML	Brownish black (5 YR 2/1) moist.
0.5 - 1.0	SILTY CLAY WITH SOME SAND AND GRAVEL	CL	Moderate yellowish brown (10 YR 5/4) plastic, slightly cohesive, moist, sand and gravel composed of limestone, subangular, 1/16 to 3/4 inch in diameter.
1.0 - 6.5	SILTY CLAY/ CLAY WITH SOME SILT	CL	Dusky brown (5 YR 2/2) plastic, slightly cohesive, moist, some small limestone pebbles less than 1/16-inch diameter from 5.0 to 6.5 feet.
6.5 - 10.0	SILTY SANDY CLAY WITH SOME GRAVEL	CL	Moderate yellowish brown (10 YR 5/4) nonplastic, noncohesive, dry, 55 percent clay; 30 percent silt and clay; 5 percent gravel composed of limestone 1/4-inch diameter, subangular, from 6.5 to 7.0 feet increase in gravel content.
10.0 - 12.0	SILTY CLAY	CL	Light olive gray (5Y 5/2) slightly plastic, noncohesive, slightly moist to dry.
12.0 - 16.0	CLAYEY GRAVEL WITH SOME SILT	GC	No color, 1.4-inch to 1.2-inch limestone gravel, subangular to angular, dry.
16.0 - 19.0	SAND	SP	Dark yellowish orange (10 YR 6/6) well-sorted, very fine quartz sand.

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TABLE A-59 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-61

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
19.0 - 22.5	SANDY GRAVEL	SW	Dark yellowish orange (10 YR 6/6) poorly sorted, 1/4-inch to 2-inch diameter.

TOTAL DEPTH OF BOREHOLE: 22.5 Feet

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TABLE A-60

LITHOLOGIC LOG OF SOIL BORING RSB-62

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 3.0	CLAY	CL	Moderate brown (5 YR 4/4).
3.0 - 5.0	CLAYEY GRAVEL	GC	Moderate yellowish brown (10 YR 5/4) with white chalky coated pebbles.
5.0 - 12.0	CLAYEY SAND	SC	Light brown (5 YR 5/6) uniform, fine sand.
12.0 - 18.0	SAND	SP	Moderate yellowish brown (10 YR 5/4) uniform.
18.0 - 24.0	GRAVEL WITH SAND	GW	Moderate yellowish brown (10 YR 5/4) loose, 50 percent gravel; 30 percent sand; 20 percent clay and fines, wet.
24.0 - 24.8	CLAY	CL	Yellowish gray (5 Y 7/2) with pale olive (10 Y 6/2) and dusky yellow (5 Y 6/4) streaks, plastic, slightly cohesive, slightly moist.
24.8 - 25.0	LIMESTONE	--	Yellowish gray (5Y 7/2) dry, shaly.

TOTAL DEPTH OF BOREHOLE: 25.0 Feet

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TABLE A-61

LITHOLOGIC LOG OF SOIL BORING RSB-63

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.5	SILTY SAND	SM	Dark yellowish brown (10 YR 4/2) fine sand, loose, slightly moist, roots, 60 percent sand, 40 percent silt.
0.5 - 10.0	GRAVELLY CLAY	CL	Moderate brown (5 YR 4/4) with white chalky coated pebbles, weathered, 20 percent gravel; 20 percent sand; 60 percent clay, fine sand, subrounded to subangular, coarse sand and pebbles, few cobbles, slightly moist to dry, plastic, noncohesive, breaks into blocks, increasing sand content from 8.0 to 10.0 feet, black streaks throughout.
10.0 - 11.0	SAND WITH SILT	SM	Dark yellowish brown (10 YR 6/6) 60 percent sand; 40 percent silt; uniform, fine sand, loose, dry.
11.0 -19.0	SAND	SP	Dark yellowish orange (10 YR 6/6) fine sand, uniform, loose, dry from 14.0 to 19.0 feet, moist.
19.0 - 26.0	GRAVEL AND SAND	GM	Dark yellowish orange (10 YR 6/6) 70 percent gravel; 20 percent sand; 10 percent fines, rounded to subrounded, moderately subrounded, shells and shell fragments, loose, wet.

TOTAL DEPTH OF BOREHOLE: 26.0 Feet

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**Drilled by flight auger

TABLE A-62

LITHOLOGIC LOG OF SOIL BORING RSB-64

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.5	SILTY SAND	SM	Dark yellowish brown (10 YR 4/2) fine sand, loose, slightly moist, roots, 60 percent sand; 40 percent silt.
0.5 - 8.0	GRAVELLY CLAY	CL	Moderate brown (5 YR 4/4) with white chalky coated pebbles, weathered, 20 percent gravel; 20 percent sand; 60 percent clay, dry, blocky, plastic, noncohesive, decreasing gravel and sand content at 7.0 feet, black streaks throughout.
8.0 - 12.0	CLAY	CL	Moderate brown (5 YR 4/4) with very pale orange (10 YR 8/2) discoloration, plastic, noncohesive, slightly moist, dense, black streaks thoughout.
12.0 - 18.0	SAND WITH SILT	SM	Moderate brown (5 YR 4/4) with very pale orange (10 YR 8/2) discoloration, fine sand, 50 percent sand; 50 percent silt, slightly moist, uniform.
18.0 - 30.0	SAND	SP	Light brown (5 YR 5/6) fine sand, uniform, loose, wet, some silt.
30.0 - 30.5	GRAVELLY CLAY	CL	Dusky yellow, (5 Y 6/4) plastic, rounded to subrounded, cobbles, pebbles, coarse sand, shell fragments.

TOTAL DEPTH OF BOREHOLE: 30.5 Feet

**Drilled by flight auger

*Unified Soil Classification System
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TABLE A-63

LITHOLOGIC LOG OF SOIL BORING RSB-65

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 4.0	CLAY	CL	Moderate brown (5 YR 3/4) plastic, dense, slightly moist, gravel layer from 3.0 to 3.5 feet, coated cobbles from 1 to 2 inches in diameter, subangular.
4.0 - 6.0	GRAVELLY CLAY WITH SAND	CL	Dark yellowish brown (10 YR 4/2) 20 to 30 percent gravel; 20 percent sand, 50 percent clay, plastic, dry, subangular to subrounded.
6.0 - 13.0	GRAVELLY CLAY WITH SAND	CL	Dark yellowish brown (10 YR 4/2) decrease in percent gravel and grain size to very coarse sand with minor pebbles, from 12.0 to 13.0 feet pale yellowish brown (10 YR 6/2) lenses of limey clay with gravel.
13.0 - 17.5	CLAYEY GRAVEL	GC	Mottled yellowish gray (5Y 7/2 to 5 Y 8/4) limestone.

TOTAL DEPTH OF BOREHOLE: 17.5 Feet

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TABLE A-64

LITHOLOGIC LOG OF SOIL BORING RSB-66

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 0.5	SILTY CLAY WITH SAND AND GRAVEL	ML	Dusky brown (5 YR 2/2) slightly plastic, slightly noncohesive, slightly moist.
0.5 - 1.0	SILTY CLAY	ML	Grayish yellow, (5 Y 8/4) slightly plastic, slightly cohesive, slightly moist with cobbles composed of limestone.
1.0 - 5.0	CLAYEY GRAVEL AND COBBLES	GC	Very light gray (N 8) subangular to angular cobbles, less than 1 inch to 3 inches in diameter composed of limestone.
5.0 - 5.5	GRAVELLY CLAY WITH SILT	CL	Mottled dark yellowish orange (10 YR 6/6) with dusky brown (5 YR 2/2) slightly plastic, noncohesive, slightly moist, gravel, 1/4 inch to 3/4 inches in diameter.
5.5 - 9.0	SILTY CLAY WITH SAND	ML	Dusky brown (5 YR 2/2) slightly plastic, slightly cohesive, slightly moist.
9.0 - 12.0	SANDY SILTY CLAY	ML	Moderate brown (5 YR 4/4) plastic, slightly cohesive, slightly moist to dry, some white limey streaks.
12.0 - 15.5	CLAYEY GRAVEL/ GRAVELLY CLAY	GC/CL	Moderate brown (5 YR 4/4) nonplastic, noncohesive, dry, gravel composed of limestone, subrounded, 1/4 inch to 1 inch in diameter.
15.5 - 18.0	CLAYEY SANDY GRAVEL	GC	Light brown (5 YR 5/6) slightly plastic, slightly cohesive, slightly moist, gravel composed of limestone, subrounded to subangular, 1/4 to 1 inch in diameter.

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TABLE A-64 (continued)
LITHOLOGIC LOG OF SOIL BORING RSB-66

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
18.0 - 30.0	SILTY SAND	SM	Light brown (5 YR 5/6) very fine, well-sorted, slightly moist.
30.0 - 33.0	SAND	SP	Light brown (5 YR 5/6) poorly sorted.

TOTAL DEPTH OF BOREHOLE: 33.0 Feet

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TABLE A-65

LITHOLOGIC LOG OF SOIL BORING RSB-67

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0-0.5	GRASS AND TOPSOIL	--	
0.5-5.0	CLAYEY GRAVEL	GC	Gravel is weathered limestone, light gray (N 6), fine- to medium-grained, angular to subangular; clay is reddish yellow (7.5 YR 7/8), slightly cohesive; some fine-grained sand; soil is oxidized; slightly damp.
5.0-9.0	LIMESTONE	--	White (N 8), hard, dry. At 5-9 feet, 15 percent recovery from core sampler.
9.0-18.0	LIMEY SHALE	--	Dark gray (N 4), fissile, friable, slightly moist.
18.0	LIMESTONE	--	Light gray (N 7 to N 8), hard, no visible fossils, dry. At 18.0 feet, auger refusal.

TOTAL DEPTH OF BOREHOLE: 18.0 Feet

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TABLE A-66

LITHOLOGIC LOG OF EXPLORATORY BORING P-24EB

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0-27.0	FOSSILIFEROUS LIMESTONE	--	Light gray to medium gray (N 4 to N 6), some clay interbeds, weathered, dry. At 24-25 feet, hard layer.
27.0-58.0	SILTY SAND	ML	Light gray (N 4 to N 5), sand is very fine to fine-grained, well sorted, soft, some cementation; some clay. At 32-40 feet, color is yellowish orange (10 YR 6/6 to 10 YR 8/6). At 41-42 feet, sandy limestone, white to medium gray (N5 to N9). At 52 feet, lignite layer. At 52-58 feet, color change to yellowish gray (5 Y 8/1).
58.0-80.0	CLAYEY SILT	CL	Medium light gray (N6), firm, slightly cohesive, some light cementation. At 68-72, color grades to very pale green to medium gray (10 G 8/2 to N5). At 72-78, color is yellowish gray (5 Y 8/1), grading to sand.
80.0-84.0	SILTY SAND	ML	Yellowish gray (5 Y 8/1), fine- to medium-grained, sub- to well-rounded, interbedded, strongly cemented layers.

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TABLE A-66 (continued)
LITHOLOGIC LOG OF EXPLORATORY BORING P-24EB

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
84.0-140	SAND	SP	Yellowish gray (5 Y 8/1), fine- to medium-grained, subrounded to well-rounded, interbedded well cemented layers. At 130 feet, lignite layer.
140-160	SILTY CLAYSTONE/ CLAYEY SILTSTONE	CL	Pale blue green (5 BG 7/2), soft to moderately cemented, trace pyrite.
160-168	SILT/SILTY CLAY	CL	Medium gray (N5 to N6), soft, moderately cohesive.
168-186	SILTY SAND	SM	Yellowish gray (5 Y 8/1), very fine- to fine-grained, well sorted, some cementation, trace lignite.
186-202	SILTY CLAY/CLAYEY SILT	CL	Medium gray, slightly cohesive; trace sand. At 192 feet, color change to pale blue green (5 BG 7/2); some medium dark gray (N3) shale.
202-203	LIMESTONE	--	Yellowish gray (5 Y 8/1), fine-grained, hard, massive, strong reaction with HCl.

TOTAL DEPTH OF BOREHOLE: 203 Feet

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TABLE A-67

LITHOLOGIC LOG OF EXPLORATORY BORING P-25EB

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0-12.0	GRAVELLY SILTY CLAY	GC	Dark yellowish orange to grayish orange (10 YR 6/6 to 10 YR 7/4), soft, noncohesive; gravel is fine- to medium-grained, subangular weathered limestone fragments.
12.0-33.0	SILTY CLAY	CL	Very pale orange (10 YR 8/2), soft, cohesive. At 17-18 feet, silty gravel, weathered limestone up to 1-inch diameter, subangular. At 18 feet, color change to grayish orange (10 YR 7/4), moderately cohesive.
33.0-62.0	FOSSILIFEROUS LIMESTONE WITH SHALE	--	Gray (N3-N6), some shell fragments; shale is brittle, strong reaction with HCl. At 33-34 feet, weathered. At 37-41 feet, some shale. At 41-44 feet, shell fragments more numerous. At 44-54 feet, shale with limestone and limey clay interbeds. At 54-57 feet, harder limestone.

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TABLE A-67 (continued)
LITHOLOGIC LOG OF EXPLORATORY BORING P-25EB

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
62.0-88.0	SILTY CLAY/ CLAYEY SILT	CL	Medium dark gray (N4), firm, cohesive; dense. At 69 feet, color change to light greenish gray (5 GY 8/1). At 76-78 feet, some lignite. At 78-80 feet, color change to medium bluish gray (5 B 5/1), some milky white sandstone. At 85 feet, thin layer of pyrite. At 80-88 feet, more clay.
88.0-146	SANDY SILT/ SILTY SAND	ML	Yellowish gray (5 Y 8/1); sand is fine- to very fine-grained; some gravel, fine- to medium-grained, angular. At 88-96 feet, some lignite. At 100 feet, more sand. At 107-109 feet, sandstone, white. At 109-114 feet, some gravel.
146-162	SANDSTONE/ SILTSTONE	ML	Yellowish gray (5 Y 8/1), moderately cemented, very fine- to medium-grained.
162-172	SILTSTONE/ CLAYSTONE	CL	Light greenish gray, weakly to strongly cemented; some sand, very fine- to fine-grained.
172-182	SILTSTONE/ SANDSTONE	CL/SP	Light greenish gray, very fine-grained, weakly to strongly cemented.

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TABLE A-67 (continued)
LITHOLOGIC LOG OF EXPLORATORY BORING P-25EB

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
182-194	SILTY SAND	ML	Yellowish gray (5 Y 8/1), very fine- to medium-grained, rounded to subangular, weakly cemented.
194-206	SILTY CLAY	CL	Greenish gray (5 G 6/1), soft, moderately cohesive.
206-216	SITLY SAND	ML	Yellowish gray (5 Y 8/1), very fine- to fine-grained.
216-225	SILTY SAND	CL	Same as 194-206 feet.
225-228	SILTY SAND	ML	Same as 206-216 feet.
228-234	SANDY SILT/ SILTY CLAY	ML/CL	Greenish gray (5 G 6/1), weakly cemented.
			At 233 feet, less sand.
234-235	LIMESTONE	--	White to medium gray (N 5 to N 9), hard, strong reaction with HCl.

TOTAL DEPTH OF BOREHOLE: 235 Feet

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TABLE A-68

LITHOLOGIC LOG OF EXPLORATORY BORING P-26EB

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0-5.0	ASPHALT AND GRAVEL FILL	--	Medium brown; asphalt cover.
5.0-23.0	CLAYEY LIMESTONE	--	Pinkish gray to yellowish gray (5 YR 8/1 to 5 Y 8/1), some fossils, weathered. At 9.0 feet, interbedded clay, grayish orange (10 YR 7/4), dense, cohesive; limestone is highly weathered. At 15.0 feet, mostly limey gravelly clay. At 20.0 feet, clay is yellowish gray (5 YR 8/1).
23.0-36.0	LIMEY CLAYEY SHALE	--	Dark to medium gray (N3-N5), brittle; clay is dense, cohesive.
36.0-41.0	FOSSILIFEROUS LIMESTONE	--	Medium gray (N5-N6), oyster shell fragments.
41.0-63.5	CLAYEY SHALE	--	Same as 23-36 feet, appears to have an oily matrix.
63.5-74.0	SILTY CLAY	CL	Light olive gray (5 Y 6/1), dense, cohesive, moderately plastic.
74.0-92.0	SANDSTONE	SP	Light gray to pinkish gray (N7 to 5 YR 8/1), very fine-grained, lightly cemented. At 76.0 feet, trace pyrite. At 86.0 feet, trace lignite. At 92.0 feet, softer.

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TABLE A-68 (continued)
LITHOLOGIC LOG OF EXPLORATORY BORING P-26EB

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
92.0-112	SILTY CLAY	CL	Brownish gray (5 YR 6/1), semicohesive, some clay is dense.
112-165	SILTY SAND/ SANDY SILT	SM	Pinkish to yellowish grayish (5 YR 8/1 to 5 Y 8/1), very fine-grained, well rounded and sorted.
			At 145 feet, silt layer.
165-169	SANDSTONE	SP	White (N9), very fine-grained, well cemented, hard.
169-183	SILT	ML	Light bluish gray to light greenish gray (5 E 7/1 to 5 G 6/1), soft, noncohesive; trace clay; some lignite and pyrite.
183-215	SILTY SAND/ SANDY SILT	SM	Light olive gray (5 Y 6/1), lithologic properties same at 122-169 feet; interbedded silt.
215-230	SILTY CLAY/ CLAYEY SILT	CL-ML	Light greenish gray to greenish gray (5 G 8/1 to 5 G 6/1), noncohesive.
			At 230 feet, some lignite.
230-236	SILTY CLAYEY SAND	SM-SC	Same color as above, interbedded.
			At 234 feet, some lignite.
			At 236 feet, thin white silt layer.
236-240	LIMESTONE	--	Yellowish gray (5 Y 8/1) to white (N9), slightly dense.

TOTAL DEPTH OF BOREHOLE: 240 Feet

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APPENDIX B

LITHOLOGIC LOGS FOR

UPPER ZONE MONITOR WELLS

APPENDIX B

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TABLE B-1

LITHOLOGIC LOG OF MONITOR WELL HM-87

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	ASPHALT AND SUBGRADE	--	
0.5 - 35	CLAYEY SILT	CL	Yellowish brown (10 YR 5/4) 50 percent silt, 50 percent clay, soft, plastic. Interbedded with pale yellow (2.5Y 7/4) 85 percent silt, 15 percent clay, soft to firm, plastic, cohesive, minor black mottling, some limestone stringers, trace fine sand.
35.0 - 37.0	SHALY LIMESTONE	--	White shaly limestone, hard, brittle, calcareous silt interbeds, hard, brittle.
37.0 - 42.0	CLAYEY SILT/LIMESTONE	--	Gray (5Y 6/1), 80 percent silt, 20 percent clay, soft, plastic, interbedded with gray limestone, hard, brittle, shell fragments, harder with depth. Softens at 41 feet.

TOTAL DEPTH OF BOREHOLE: 42 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-2

LITHOLOGIC LOG OF MONITOR WELL HM-88

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 7.0	SILTY CLAY	CL	Grayish orange (10 YR 7/4), plastic, slightly cohesive.
7.0 - 22.0	SANDY SILT	SM	Yellow orange (10 YR 5/4), 85 percent silt, 15 percent sand, sand is very fine- to fine-grained, well rounded.
22.0 - 27.0	GRAVELLY SAND	GP	Varicolored, sand is coarse- to medium-grained, rounded to subangular, loose.
27.0 - 32.0	GRAVELLY SILT	ML	Grayish orange (10 YR 7/4), soft, plastic, gravel is angular to subrounded approximately percent.
32.0 - 37.0	GRAVELLY SILT	ML	Yellowish orange (10 YR 5/4), gravel approximately 10 percent fine- to medium-grained, subrounded.
37.0 - 45.0	SANDY GRAVEL	GP	Varicolored, fine- to medium-grained, subangular to subrounded.
45.0 - 47.0	FOSSILIFEROUS LIMESTONE	--	Gray (N4 - N8), abundant shell fragments, minor shale and clay.

TOTAL DEPTH = 47.0 FEET

*Unified Soil Classification System
ASTM D-2487

TABLE B-3

LITHOLOGIC LOG OF MONITOR WELL HM-89

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 8.0	SILTY CLAY	SL	Light brown (5 YR 5/2), soft, plastic, trace gravel, fine- to medium-grained, rounded.
8.0 - 36.0	CLAY	CH	Light brown (5 YR 5/2), soft, plastic, moderately cohesive.
36.0 - 49.0	GRAVEL	GP	Varicolored, fine- to medium-grained, rounded to subrounded, saturated.
49.0 - 52.0	FOSSILIFEROUS LIMESTONE	--	Dark gray (N8), abundant shell fragments, Walnut Formation.

TOTAL DEPTH OF BOREHOLE: 52.0 FEET

*Unified Soil Classification System
ASTM D-2487

TABLE B-4

LITHOLOGIC LOG OF MONITOR WELL HM-90

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 10.0	CLAY	CH	Dark gray (N 3), firm, sticky, cohesive.
10.0 - 12.0	SILTY CLAY	CL	Dark olive gray (5 Y 6/1), firm, cohesive, trace medium-grained sand.
12.0 - 20.0	CLAYEY SILT	ML	Grayish orange (10 YR 7/4), firm, cohesive, some medium- to coarse-grained sand.
20.0 - 32.0	SILTY SANDY GRAVEL, GRAVELLY SAND	GM-SP	Grayish orange (10 YR 7/4), gravel is fine- to medium-grained, angular, consisting mainly of fossil fragments, sand is fine- to coarse-grained, angular rounded.
32.0 - 42.0	SANDY GRAVELLY SILTY CLAY	SP	Dark yellowish orange (10 YR 6/6), soft, sticky, gravel is medium- to fine-grained consisting mainly of rounded limestone.
42.0 - 52.0	SILTY CLAY WITH SAND	CL	Yellowish orange (10 YR 6/6), soft, sticky, trace fine- to medium-grained sand.
52.0 - 61.0	SANDY GRAVEL	GP	Varicolored, gravel is rounded with angular shell fragments, sand is fine to coarse, subangular.
61.0 - 61.5	LIMESTONE	--	Medium gray to white (N 6 - N 9), hard, Walnut Formation.

TOTAL DEPTH OF BOREHOLE: 61.5 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-5

LITHOLOGIC LOG OF MONITOR WELL HM-91

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 1.0	CONCRETE	--	
1.0 - 3.5	CLAYEY SILT	CL	Dusky-grayish brown (5 YR 2.5/2) slightly damp, slightly cohesive.
3.5 - 9.0	SANDY CLAYEY SILT	ML	Light brown (5 YR 5/2), sticky, non-cohesive; some varicolored subangular 1/4-inch chert grains. At 6.5 feet, color change to (5 YR 5/6).
9.0 - 13.0	GRAVELLY AND SANDY, CLAYEY SILT	CL	Interbedded, light brown (5 YR 5/6), sticky; sand is very fine to coarse grained, gravel is subangular.
13.0 - 18.0	CLAYEY GRAVELLY SILT	CL	Light brown (5 YR 5/6), sticky; limestone gravel is subangular to subrounded; minor clay.
18.0 - 20.0	SANDY CLAYEY SILT	CL	Light brown (5 YR 5/6) sticky; sand is coarse and subangular.
20.0 - 30.0	SANDY SILT	ML	Light brown (5 YR 5/6) sticky; sand is fine to coarse subangular grains; clay interbeds.
30.0 - 50.0	SANDY CLAYEY SILT	CL	Interbedded light brown (5 YR 5/6) sticky, slightly cohesive; sand is very fine to fine grained. At 35.0-40.0 feet, not much retention in screen.
50.0 - 60.0	GRAVELLY SAND	GP	Varicolored, sand and gravel is fine to medium grained, angular to well rounded, gravel consists of limestone, quartz, and chert.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-5 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-91

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
60.0 - 62.0	FOSSILIFEROUS LIMESTONE	--	Light gray to dark gray, very well cemented, shell fragments (oysters).

TOTAL DEPTH OF BOREHOLE: 62 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-6

LITHOLOGIC LOG OF MONITOR WELL HM-92

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 2.0	GRASS, ROOTS AND FILL	--	
2.0 - 2.5	GRAVELLY FILL	--	
2.5 - 5.0	CLAY	CH	Gray black (N 2), damp, plastic, sticky; minor gravel, medium grained, subangular.
5.0 - 7.0	GRAVELLY CLAY	CL	Olive black (5 YR 2/1), wet, plastic; 10 percent gravel, fine to coarse, subangular.
7.0 - 15.0	CLAYEY SILT	ML	Light brown (5 YR 5/6) moderately cohesive, sticky; minor gravel, fine to coarse, subangular.
15.0 - 17.0	SILTY SAND	SM	Light brown (5 YR 5/6) moderately cohesive, sticky; sand is very fine grained.
17.0 - 20.0	CLAYEY SILT	ML	Light brown (5 YR 5/6) moderately cohesive, sticky, minor sand.
20.0 - 37.0	SANDY SILT	SM	Light brown (5 YR 5/6) cohesive moderately plastic, sticky; sand is very fine grained. At 25.0-28.0, gravel stingers. At 30.0-32.0, gravel stringers.
37.0 - 45.0	GRAVELLY SAND	GP	Light brown (5 YR 5/6) sand is fine to coarse grained; gravel is varicolored, fine to coarse grained, subangular to rounded.
45.0 - 58.0	SILTY CLAY	CL	Light brown (5 YR 5/6) very dense, cohesive, plastic, sticky.

*Unified Soil Classification System ASTM D-2487

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TABLE B-6 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-92

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
58.0 -61.75	SILTY SAND	SM	Varicolored, sand is fine to coarse grained, subangular; silt is light brown (5 YR 5/6) moderately cohesive.
61.75	FOSSILIFEROUS LIMESTONE	--	Light gray to dark gray, very well cemented, shell fragments (oysters).

TOTAL DEPTH OF BOREHOLE: 61.75 Feet

*Unified Soil Classification System
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**Drilled by flight auger

TABLE B-7

LITHOLOGIC LOG OF MONITOR WELL HM-93

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 2.0	ASPHALT AND FILL	--	
2.0 - 5.0	SANDY. SILTY CLAY	CL	Light brown (5 YR 5/6) sticky; slightly cohesive; sand is fine grained; minor gravel.
5.0 - 8.0	SANDY SILT	ML	Light brown (5 YR 5/6) slightly cohesive; sand is very fine grained.
8.0 - 16.0	GRAVEL	GP	Varicolored, fine to medium grained, subangular to rounded; clay is interbedded, grayish orange (10 YR 7/4).
16.0 - 33.0	SILTY SAND, SANDY SILT	SM	Grayish orange (10 YR 7/4) sand is very fine grained, slightly cohesive. At 22 feet, less sand.
33.0 - 37.0	SILTY CLAY	CL	Grayish orange (10 YR 7/4) moderately cohesive.
37.0	FOSSILIFEROUS LIMESTONE	--	Light to medium gray, very well cemented, shell fragments (oysters).

TOTAL DEPTH OF BOREHOLE: 37 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-8

LITHOLOGIC LOG OF MONITOR WELL HM-94

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 7.0	SANDY CLAY	CL	Yellow brown (10 YR 5/4), clay is cohesive, plastic, sand is medium- to coarse-grained, subrounded, mainly white opaque grains.
7.0 - 19.0	SILTY CLAY/ CLAYEY SILT	CL/ML	Grayish orange (10 YR 7/4), cohesive, moderately plastic, soft.
19.0 - 26.5	SANDY GRAVELLY SILT	ML	Silt is gray orange (10 YR 7/4), cohesive, slightly plastic, fine-grained sand to very coarse gravel, poorly sorted, varicolored.
26.5 - 55.0	SILTY CLAY	CL	Light brown (5 YR 6/4), cohesive, plastic, soft.
55.0 - 59.5	COBBLEY GRAVEL	GP	Varicolored, subrounded to rounded, gravel is fine- to medium-grained, cobble-size cuttings.
59.5 - 61.0	FOSSILIFEROUS LIMESTONE	--	Gray (N 8 to N 4), hard, brittle, very well cemented.
61.0 - 66.0	SANDY CLAY/ CLAYEY SAND	CL/SC	Gray (N 3), cohesive clay, slightly plastic, very fine-grained sand.
66.0 - 73.0	SILTY CLAY/ SHALE	CL	Gray (N 6), moderately plastic, hard, trace fine-grained sand.
73.0 - 79.0	SHALE/ SANDSTONE	--	Shale is same as above. Sandstone is pinkish gray (5 YR 8/1), fine-grained sand, poorly cemented, sandstone and shale interbedded, shale is predominant.
79.0 - 87.0	SANDSTONE	--	Pinkish gray (5 YR 8/1), fine-grained sand, poorly cemented, non-uniform cementation.
87.0 - 93.5	CLAY/SHALE	CL/CH	Medium light gray (N 6), plastic to highly plastic, some silt.

*Unified Soil Classification System ASTM D-2487

**Borehole grouted with neat cement from 59.0 feet to 121.0 feet bls

TABLE B-8 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-94

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
93.5 - 99.0	SANDSTONE/ CLAY	--	Very light gray (N 8), fine-grained sand with some clay, poorly cemented, frequent clay interbeds, same as 87.5 - 93.5.
99.0 - 121.0	CLAYEY SANDSTONE	--	Very light gray (N 8), fine-grained sand, poorly cemented.

TOTAL DEPTH OF BOREHOLE: 121.0 Feet

*Unified Soil Classification System ASTM D-2487

**Borehole grouted with neat cement from 59.0 feet to 121.0 feet bls

TABLE B-9

LITHOLOGIC LOG OF MONITOR WELL HM-95; SOIL BORING RSB-1

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 7.0	CLAY	CH	Reddish (5 YR 4/20 very cohesive, plastic.
7.0 - 20.0	SANDY SILTY CLAY	CL	Gray orange (10 YR 7/4) moderately cohesive, plastic; approximately 20 percent silt; sand is varicolored, very fine to very coarse grained.
20.0 - 26.0	CLAY	CH	Buff (10 YR 7/4) very plastic, very cohesive.
26.0 - 40.0	SANDY SILT-SILTY SAND	SM	Red brown (10 YR 5/4); silt is sand is fine to very fine grained; slightly cohesive, slightly plastic.
40.0 - 44.5	GRAVELLY SAND	GP	Varicolored, subrounded, medium to very coarse grained sand, medium grained gravel.
44.5 - 45.0	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8) angular chips of shell fragments (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 45 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-10

LITHOLOGIC LOG OF MONITOR WELL HM-96; SOIL BORING RSB-7

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 4.0	CLAY WITH SAND	CL	Red brown (5 YR 4/2) dry, plastic, cohesive; less than 5 percent sand, coarse grained, subangular fragments.
4.0 - 6.0	SANDY GRAVEL	GP	Varicolored, coarse grained, subrounded.
6.0 - 32.0	SANDY CLAY	CL	Buff (10 YR 7/4) moderately plastic, cohesive; sand is varicolored, coarse grained, subangular, approximately 20 percent.
32.0 - 40.0	SILTY CLAY	CL	Red brown (5 YR 4/2) slightly cohesive, moderately plastic; some fine sand, less than 5 percent, very fine grained.
40.0 - 47.0	SILTY SAND	SM	Red brown (5 YR 4/2); sand is well rounded, medium to very coarse grained; silt is nonplastic, noncohesive.
47.0 - 52.5	GRAVEL	GP	Varicolored, subrounded grains, fine to very coarse grained.
52.5 - 54.0	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8), brittle angular shell fragments (Walnut Formation).

TOTAL DEPTH OF BOREHOLE: 54 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-11

LITHOLOGIC LOG OF MONITOR WELL HM-97

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 7.0	TOP SOIL AND SANDY SILT	ML	Brown (10R 3/4), varicolored, angular grains, 35 percent sand, medium to very coarse; silt is nonplastic, noncohesive.
7.0 - 35.0	SILTY SANDY CLAY	CL	Gray orange (10 YR 7/4), moderately cohesive, moderately plastic
35.0 - 43.0	CLAY	CH	Yellow brown (10 YR 5/4), very plastic, very cohesive.
43.0 - 47.0	GRAVELLY SAND	GP	Varicolored, well rounded, medium to very coarse grained.
47.0 - 51.0	GRAVEL	GP	Varicolored, well rounded, fine to very coarse grained.
51.0 - 51.5	FOSSILIFEROUS LIMESTONE	--	Gray (N 7 to N 3) brittle angular shell fragments (Walnut Formation).
51.5 - 71.0	CLAYEY SAND	SC	Gray (N 7) very fine grained, slightly cohesive, nonplastic.
71.0 - 76.0	SANDY CLAY	CL	Gray (N 5 to N 4) moderately cohesive, slightly plastic; approximately 10 percent very fine sand.
76.0 -76.25	SANDSTONE	SW	Light gray (N 8) very well cemented, very fine grained, hard, brittle.
76.25 -80.0	CLAYEY SANDSTONE	SC	Gray (N 7) very fine grained, well rounded, approximately 70 percent sand.

TOTAL DEPTH OF BOREHOLE: 80 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-12

LITHOLOGIC LOG OF MONITOR WELL HM-98; SOIL BORING RSB-16

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.0	CLAYEY SILT	ML	Moderate brown (5 YR 3/4), slightly cohesive, dry.
1.0 - 6.5	SILTY CLAY	CL	Dusky brown (5 YR 2/2), cohesive, moderately plastic, dry.
			At 3.5-4.0 feet, color change to moderate brown (5 YR 4/4).
6.5 - 14.0	CLAYEY SILT	ML	Moderate brown (5 YR 4/4), slightly cohesive, nonplastic, dry.
			At 9.0-14.0 feet, color change to dark yellowish orange (10 YR 6/6), less clay.
14.0 - 19.0	SANDY GRAVEL	GM	Dark yellowish orange (10 YR 6/6), gravel is varicolored, fine- to coarse-grained, angular to subrounded; sand is fine to coarse; dry.
19.0 - 25.0	SANDY SILT	SM	Dark yellowish orange (10 YR 6/6) with whitish streaking, silt is moderately cohesive; sand is fine-grained; dry to 23.0 feet.
			At 23.0 feet, color change to very pale range (10 YR 8/2), moist.
25.0 - 31.0	SILTY GRAVELLY SAND	GM	Varicolored, sand and gravel are fine- to coarse-grained, subangular to subrounded grains.
			At 28.75 feet, saturated, more fine sand and silt, less gravel.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-12 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-98; SOIL BORING RSB-16

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
31.0 - 31.5	DENSE LIMESTONE	--	Tan, no fossils, dry.

TOTAL DEPTH OF BOREHOLE: 97 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-13

LITHOLOGIC LOG OF MONITOR WELL HM-99; SOIL BORING RSB-18

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 5.0	CLAYEY SILT	ML	Moderate brown to dusky yellowish brown (5 YR 3/4 to 10 YR 2/2), moderately cohesive, nonplastic, moist.
5.0 - 9.0	SILT	MH	Light brown to moderate yellowish brown (5 YR 5/6 to 10 YR 5/4), slightly cohesive, nonplastic; some fine- to coarse-grained whitish limestone gravel and sand as stringers; some clay; moist.
9.0 - 11.0	GRAVELLY SILT	GM	Light brown to moderate yellowish brown (5 YR 5/6 to 10 YR 5/4), noncohesive; gravel is medium- to coarse-grained, subangular to subrounded.
11.0 - 27.0	CLAYEY SILT	ML	Light brown to moderate yellowish brown (5 YR 5/6 to 10 YR 5/4), slightly cohesive, nonplastic; moist. At 25.0 feet, TIP reading was 10-40 ppm. At 25.0-27.0 feet, whitish caliche, friable.
27.0 - 38.5	SANDY SILT-SILTY SAND	SM	Light brown (5 YR 5/6), slightly cohesive, sand is fine-grained. At 30.0 feet, TIP reading was 7.5 ppm. At 33.0 feet, saturated. At 35.0 feet, TIP reading was 15-20 ppm.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-13 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-99; SOIL BORING RSB-18

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
38.5 - 44.0	SANDY GRAVEL	SP	Varicolored, sand and gravel are fine to coarse, some oyster fossils in gravel, loose; trace limestone and very well cemented, coarse-grained sandstone, angular to subangular.
44.0	DENSE LIMESTONE	--	Auger refusal, no cuttings obtained in core.

TOTAL DEPTH OF BOREHOLE: 44.0 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-14

LITHOLOGIC LOG OF MONITOR WELL HM-110

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 4.0	GRAVELLY SILTY CLAY	CL	Brown (5 YR 6/4), very slightly damp, 60 percent clay, 30 percent silt, 10 percent gravel, moderately cohesive, moderately plastic; gravel is of angular, medium grained, whitish.
4.0 - 20.0	CLAYEY SILT	ML	Light brown (5 YR 6/4), moderately cohesive, slightly plastic.
20.0 - 28.5	CLAYEY GRAVELLY SAND	SP	Light brown (5 YR 5/6), damp; sand is medium to coarse, subangular; gravel is fine to medium grained, subangular; clay is moderately plastic, cohesive. 50 percent sand, 40 percent gravel, 10 percent clay 60 percent gravel from 25 to 28.5 saturated at 29 feet below land surface.
28.5 - 32.5	SILTY SAND	SM	Light brown (5 YR 5/6), saturated; sand is fine to very fine grained, well rounded.
32.5 - 34.0	SILTY CLAY	CL	Moderately brown (5 YR 4/4), very cohesive, plastic, hard.
34.0 - 37.0	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 7), from 34 to 35 limestone is well weathered, competent at 35 feet bls, brittle angular shell fragments with iron stain (oxidation).

TOTAL DEPTH OF BOREHOLE: 37 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-15

LITHOLOGIC LOG OF MONITOR WELL HM-111; SOIL BORING RSB-24

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 3.0	SILTY CLAY	CL	Moderate brown (5 YR 4/4), moderately cohesive, nonplastic, moist.
3.0 - 5.0	SILT	MH	Grayish orange (10 YR 7/4), noncohesive, friable; minor gravel and caliche, gravel is subangular to rounded, fine- to medium-grained, varicolored, limestone; moist.
5.0 - 15.0	SANDY SILTY GRAVEL	GM	Varicolored gravel, fine- to coarse-grained, angular to well-rounded; silt is noncohesive; sand is fine-grained; silt and sand vary in color from pinkish gray to light brown (5 YR 8/1 to 5 YR 6/4). At 13.0-13.5 feet, pure fine sand.
15.0 - 28.0	CLAYEY SILT	ML	Light brown (5 YR 5/6), slightly cohesive, nonplastic; trace gravel, subangular to rounded; moist.
28.0 - 43.0	SANDY SILT	SM	Light brown (5 YR 5/6), slightly cohesive, nonplastic; trace gravel, subangular to rounded; moist. At 30.0 feet, TIP reading was 50-60 ppm. At 32.0 feet, saturated. At 35.0 feet, TIP reading was 5-6 ppm.
43.0 - 49.0	SILTY SANDY GRAVEL	GM	Varicolored, loose, fine- to coarse-grained; silt is light brown (5 YR 5/6), slightly cohesive.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-15 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-111; SOIL BORING RSB-24

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
49.0 - 53.0	FOSSILIFEROUS LIMESTONE	--	Medium bluish gray to light bluish bray (5 B 5/1 to 5 B 7/1), dense; oyster fossils. At 49.0-49.5 feet, limestone is weathered and oxidized. At 53.0 feet, bluish gray (5 B 5/1) clay on auger bit teeth.

TOTAL DEPTH OF BOREHOLE: 53 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-16

LITHOLOGIC LOG OF MONITOR WELL HM-112; SOIL BORING RSB-25

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 25.0	GRAVELLY SILTY CLAY	CL	Light brown (5 YR 6/4), slightly plastic, moderately cohesive; gravel is subrounded, fine to medium grained whitish, matrix is very slightly damp.
25.0 - 27.0	GRAVEL	GP	Varicolored, medium to very coarse grained, subangular to subrounded, dry.
27.0 - 45.0	SILTY SAND - SANDY SILT	SM	Light brown (5 YR 5/6), very slightly cohesive, very slightly plastic, saturated; sand is very fine to fine grained, well rounded.
45.0 - 50.5	SANDY GRAVEL	GP	Varicolored, subrounded; sand is medium to very coarse grained, subrounded to subangular; gravel is fine to coarse grained, subangular to subrounded.
50.5 -50.75	FOSSILIFEROUS LIMESTONE	--	(N 4 to N 6), abundant shell fragments, hard.

TOTAL DEPTH OF BOREHOLE: 50.75 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-17

LITHOLOGIC LOG OF MONITOR WELL HM-113; SOIL BORING RSB-29

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 30.0	SILTY CLAY, CLAYEY SILT	CL/ML	Light brown to medium brown (5 YR 5/6 to 5 YR 4/4), moderately cohesive, nonplastic, moist.
30.0 - 47.0	SILTY SAND	SM	Light brown (5 YR 5/6), sand is very fine-grained; silt is slightly cohesive; saturated.
47.0 - 49.0	GRAVELLY SAND	GP	No recovery from core barrel.
			At 49.0 feet, auger refusal.

TOTAL DEPTH OF BOREHOLE: 49 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-18

LITHOLOGIC LOG OF MONITOR WELL HM-114

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 7.0	SILTY CLAY	CL	Dark reddish brown (5 YR 3/2), moderately cohesive, moderately plastic, some white friable calcareous nodules, trace angular fine-grained gravel; dry. At 5.0 to 6.0 feet, SPT indicates same material, dark reddish gray (5 YR 4/2).
7.0 - 12.0	CLAYEY SILT	ML	Reddish yellow (7.5 YR 7/8), moderately cohesive, slightly plastic; some gravel, fine to coarse grained, angular to subrounded, manganese oxide staining; dry. At 10.0 to 11.0 feet, SPT verifies.
13.0 - 25.0	SAND	SP	Yellow (10 YR 7/8), very fine-grained, soft; trace silt. At 15 to 16 feet, SPT zero percent recovery. At 20 to 21 feet, ten percent recovery; sand is a little coarser but still fine; slightly moist.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

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TABLE B-1 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-114

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
25.0 - 36.5	GRAVELLY SAND	SW	Reddish yellow (7.5 YR 7/8), medium to coarse, angular to well rounded; gravel is varicolored, fine, angular to well rounded. At 30 to 31 feet, no return from SPT. At 36.5 feet, auger refusal.

TOTAL DEPTH OF BOREHOLE: 36.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-19

LITHOLOGIC LOG OF MONITOR WELL HM-115

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	—	
0.5 - 7.0	CLAYEY SILT/ SILTY CLAY	ML/CL	Dark yellowish brown (10 YR 3/4), moderately cohesive, moderately plastic, trace fine-grained friable calcareous nodules; moist.
7.0 - 10.0	GRAVELLY CLAYEY SILT	GC	Yellow (10 YR 7/8), brittle, noncohesive; gravel is 10-20 percent, fine- to medium-grained, subangular weathered limestone.
10.0 - 14.0	CLAYEY SILT	ML	Yellow (10 YR 7/8), noncohesive.
			At 14 feet, trace sand.
14.0 - 16.0	CLAYEY GRAVELLY SILT	GC	Same as 7.0 to 10.0 feet, more gravel.
			At 15.5 to 16 feet, color change to light gray (10 YR 7/2), no gravel.
16.0 - 20.0	SILTY SAND	SM	Brown (7.5 5/4) to yellowish red (5 YR 5/8), very fine to fine, well sorted, soft, clean.
			At 17 feet, saturated.
20.0 - 24.0	SANDY GRAVEL	GP	Varicolored, fine- to coarse-grained; wet.
24.0 - 27.0	LIMEY CLAY	CL	Gray (5 YR 6/1), weathered, oxidized; moist.
27.0	LIMESTONE	---	Light gray (5 YR 7/1) to white (5 YR 8/1), hard, dense, dry.

TOTAL DEPTH OF BOREHOLE: 27.0 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-20

LITHOLOGIC LOG OF MONITOR WELL HM-116

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 4.0	CLAYEY SILT	ML	Yellowish brown (10 YR 5/8), moderately cohesive, moderately plastic; trace limey gravel, some pieces are friable, some are fine grained, angular to subrounded; moist.
4.0 - 6.0	LIMEY SILT	ML	White to light brown (N 8 to 7.5 YR 6/4), loose, brittle; weakly cemented, reactive with HCl; moist.
6.0 - 20.0	LIMEY CLAY	CL	White (N 8), brittle, friable to firm, noncohesive; moist. At 6.0 to 9.5 feet, some fine- to coarse-weathered limestone gravel, white to gray (N 8 to N 6), angular to subrounded. At 9.5 feet, reddish yellow (7.5 YR 6/6), no gravel, weathered.
20.0 - 31.5	SILTY SAND/ SANDY SILT	SM	Reddish yellow (7.5 YR 7/8), sand is very fine grained; silt is slightly cohesive; moist to damp. At 24 feet, some clay, more cohesive. At 28 feet, saturated.
31.5 - 32.0	SANDY GRAVEL	GP	Varicolored, gravel is fine- to coarse-grained, subangular to well rounded weathered limestone and chert; sand is varicolored, fine- to coarse-grained, subangular to well rounded; wet.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-20 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-116

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
32.0 - 33.0	LIMESTONE	---	Light gray (N 7), top 1 inch is weathered with hydrocarbon odor; bottom is hard; dry. At 33 feet, auger refusal.

TOTAL DEPTH OF BOREHOLE: 33.0 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-21

LITHOLOGIC LOG OF MONITOR WELL HM-117

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	ASPHALT AND FILL	---	
0.5 - 9.0	GRAVELLY SILTY CLAY	GM-GC	Reddish yellow (7.5 to 6/6), clay is moderately cohesive, moderately plastic; gravel is weathered limestone, five percent, fine- to medium-grained; some thin, soft, friable caliche zones; moist.
9.0 - 24.0	CLAYEY SILT	ML	Same as 0.5-9.0 feet but less cohesive. At 23.0-25.5 feet, caliche layer.
24.0 - 26.0	SILT	ML	Same as 9.0-24.0 feet, trace clay; very damp.
26.0 - 36.0	SILTY SAND/ SANDY SILT	SM	Yellowish red (5 YR 5/6), sand is fine-grained, well sorted; silt is slightly cohesive, soft; wet.
36.0 - 39.5	GRAVELLY SAND	GM	Varicolored, sand is fine to very coarse, subangular to well rounded, poorly sorted; gravel is fine to coarse, angular to well rounded grains of limestone, chert, and shell fragments, poorly sorted.
39.5	FOSSILIFEROUS LIMESTONE	---	Gray (N 5 to N 7), fossils consist of oyster shells.

TOTAL DEPTH OF BOREHOLE: 39.5 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-22

LITHOLOGIC LOG OF MONITOR WELL HM-118

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 10.0	CLAYEY SILT	ML	Yellowish red (5 YR 5/8), moderately cohesive, moderately plastic, some interbedded loose caliche; moist. At 5.0 to 9.0 feet, noncohesive, brittle and friable; slightly moist. At 9.5 to 10.0 feet, limey clay, gray (N 7), moderately cohesive, moderately plastic.
10.0 - 13.5	SILT	ML	Reddish yellow (7.5 7/6), soft, noncohesive, slightly moist.
13.5 - 14.0	CLAYEY SILT	ML	Reddish yellow (7.5 7/6), firm, noncohesive; vertical seams of limey clay; slightly moist.
14.0 - 18.0	SILT	ML	Same as 10.0 to 13.5 feet but damp.
18.0 - 27.0	SAND	SP	Yellowish red (5 YR 5/8), fine-grained, soft, clean, well sorted. At 19 feet, saturated. At 24.0-25.0 feet, very fine-grained with small (0.01'-0.03) well cemented sandstone concretions. At 25.0-27.0 feet, fine-grained with some larger (up to 0.15') well sandstone concretions, and coarse-grained subangular to subrounded limestone gravel; trace oyster shells.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-22 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-118

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
27.0	LIMESTONE	---	Light gray (N 8), dense, hard; dry.

TOTAL DEPTH OF BOREHOLE: 27 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-23

LITHOLOGIC LOG OF MONITOR WELL HM-119

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 1.5	CLAYEY SILT	ML	Yellowish red (5 YR 5/6), moderately cohesive, moderately plastic; trace loose caliche; moist.
1.5 - 4.0	SILTY CLAY	CL	Dark reddish brown (5 YR 3/2), moderately cohesive, moderately plastic; moist.
4.0 - 6.0	SILT	ML	Dark reddish gray (5 YR 4/2), to reddish brown (5 YR 5/3), soft, some firm to friable lenses; dry.
6.0 - 9.0	SILTY GRAVELLY SAND	GM	Yellowish red to reddish brown (5 YR 5/6 to 5 YR 4/3); slightly moist.
9.0 - 14.0	SILTY SAND/ SANDY SILT	SM	Reddish yellow (5 YR 6/8), to white (10 YR 8/2), slightly cohesive, firm to friable; slightly moist.
14.0 - 26.0	SAND	SP	Very pale brown (10 YR 8/4), very fine- to fine-grained, soft, well sorted. At 17.0 feet, saturated. At 19.0-24.0 feet, no recovery from core sampler.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-23 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-119

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
26.0 - 32.0	SANDY GRAVEL WITH COBBLES	GM	Varicolored, fine to coarse, angular to subrounded, predominantly limestone and chert; sand is same material, fine to coarse, angular to subrounded; cobbles up to 2.5 inches, angular to subangular. At 29.0-32.0 feet, no recovery from core sampler. At 32 feet, auger refusal.

TOTAL DEPTH OF BOREHOLE: 32 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-24

LITHOLOGIC LOG OF MONITOR WELL HM-120

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 3.0	SILTY SAND/ SANDY SILT	SM	Yellowish red (5 YR 5/8), slightly cohesive; sand is very fine- to fine-grained; slightly moist.
			At 2.5 to 3.0 feet, more sand, dark gray (5 YR 4/1).
3.0 - 9.0	CLAYEY SAND	SC	Light olive gray (5 Y 6/2); sand is very fine to fine; clay is moderately cohesive and plastic; slightly moist.
			At 8.5 to 9.0 feet, trace clay.
9.0 - 11.5	GRAVELLY SAND/ SANDY GRAVEL	GP	Yellowish red (5 YR 5/6), sand is fine to coarse, angular to subangular, predominantly quartz; gravel is varicolored, fine- to medium-grained, angular to well rounded; saturated.
			At 10.5-11.5 feet, more gravel.
11.5 - 14.0	LIMEY CLAY	CL	Light gray (10 YR 7/1), dense, firm, blocky; dry.
			At 11.5 feet, thin layer of hard limestone; dry.
14.0 - 19.0	LIMEY CLAY	CL	Light gray (10 YR 7/1), sticky, very cohesive, slightly plastic; wet.
			At 15.0-15.5 feet, some sand; saturated.
			At 15.5-19.0 feet, more dense limey clay; moist.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-24 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-120

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
19.0 - 20.0	LIMESTONE	---	Light gray (N 7 to N 8), dense, hard; some thin interbedded moist clay stringers. At 20.0 feet, rock flour on auger teeth; dry.

TOTAL DEPTH OF BOREHOLE: 20 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-25

LITHOLOGIC LOG OF MONITOR WELL HM-121

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 3.0	SILTY CLAY	CL	Dark brown (7.5 YR 4/2), moderately cohesive, moderately plastic; some fine-grained weathered limestone gravel; moist.
3.0 - 11.0	SILTY CLAY/ CLAYEY SILT	CL	Reddish yellow (7/5 YR 6/8), slightly cohesive, nonplastic, weathered; some white caliche zones, loose to friable; slightly moist.
			At 6.0-9.0 feet, clayey silt.
11.0 - 16.5	SILT	MH	Reddish yellow (7/5 YR 6/8), soft, loose, noncohesive; slightly moist.
			At 11.5-12.0 feet, some clay.
16.5 - 24.0	SAND	SP	Yellow (10 YR 7/6), very fine- to fine-grained, well sorted.
			At 20 feet, saturated.
			At 22 feet, trace gravel, fine- to medium-grained, subrounded limestone; sand gradational to coarser grains.
			At 22.0-24.0 feet, no recovery.
24.0 - 30.0	GRAVELLY SAND	SP	Varicolored, sand is fine to coarse, subrounded to rounded grains; gravel is fine to very coarse, subangular to subrounded; ten percent, well sorted; trace subangular weathered limestone cobbles.
			At 20 feet, OVA reading of 250 ppm above background.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-25 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-121

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
30.0 - 31.5	SANDY GRAVEL	GW	Varicolored, gravel is poorly sorted, fine- to coarse-grained, subangular to well rounded weathered limestone, oyster shells, and chert; sand has same characteristics; trace subrounded limestone cobbles; wet. At 31.5 feet, auger refusal, plug of well cemented sand and gravel, hard, reactive with HCl; no visible limestone; dry.

TOTAL DEPTH OF BOREHOLE: 31.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-26

LITHOLOGIC LOG OF MONITOR WELL HM-122

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 5.0	SILTY CLAY	CL	Dark brown, moderately cohesive, moderately plastic; some loose to friable caliche nodules; slightly moist.
			At 4.5-5.0 feet, silty sand, lightly cemented, friable; dry.
5.0 - 15.0	GRAVELLY SILTY CLAY/GRAVELLY CLAYEY SILT	GC/GM	Dark brown, slightly cohesive, slightly plastic; gravel is varicolored, fine- to coarse-grained, angular to subrounded limestone and caliche; trace cobbles; slightly moist.
15.0 - 20.0	GRAVELLY LIMEY CLAY	GC	Greenish gray, moderately cohesive; gravel is fine- to medium-grained.
			At 16.0-16.5 feet, dark brown silty clay; no gravel.
			At 18.5 feet, 2-inch light gray limestone layer, hard.
20.0 - 24.0	SILTY CLAY	CL	Dark brown, moderately cohesive, moderately plastic; some gravel, fine- to medium-grained, angular to subangular limestone; slightly moist.
			At 24 feet, wet.
24.0 - 28.5	LIMEY GRAVEL	GC	Greenish gray, fine to ??? cobble size, angular to subrounded weathered limestone; nonvisible fossils; limey clay matrix, moderately cohesive, sticky.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-26 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-122

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
28.5	LIMESTONE	---	Greenish gray, hard, no visible fossils.

TOTAL DEPTH OF BOREHOLE: 28.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-27

LITHOLOGIC LOG OF MONITOR WELL HM-123

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 3.5	SILTY CLAY	CL	Dark brown, moderately cohesive, moderately plastic, sticky, firm; moist. At 2.0 feet, thin gravelly zone with cobbles. At 3.0 feet, thin gravelly zone with cobbles.
3.5 - 13.5	CLAYEY SILT	ML	Light reddish brown, moderately cohesive, slightly plastic; some weathered limestone gravel, fine- to coarse-grained, angular to subrounded. At 6.0 feet, thin gravelly zone, fine- to coarse-grained weathered limestone. At 8.5-13.5 feet, color change to dark brown, slightly cohesive, slightly plastic; trace chert and limestone gravel.
13.5 - 20.0	CLAYEY SANDY GRAVEL WITH COBBLES	GL	Tan, gravel is fine- to coarse-grained weathered limestone, angular to subrounded; sand is fine- to coarse-grained, poorly sorted; clay is slightly sticky; numerous cobbles of weathered limestone; slightly moist.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-27 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-123

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
20.0 - 35.0	SAND		Light reddish brown, very fine-grained, soft, clean; trace silt; slightly moist. At 23.5-24.5 feet, silty sand, slightly moist. At 29.0-35.0 feet, sand is gradational to coarse-grained, poorly sorted; trace gravel, fine- to medium-grained; saturated.
35.0 - 40.5	SANDY GRAVEL		Varicolored, fine- to coarse-grained, angular to well rounded chert, limestone and fossils; some coarse sand zones. At 40.5, auger refusal, no returns.

TOTAL DEPTH OF BOREHOLE: 40.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-28

LITHOLOGIC LOG OF MONITOR WELL HM-124

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 7.0	SILTY CLAY	CL	Dark brown, moderately cohesive, slightly plastic, firm; slightly moist.
7.0 - 14.0	CLAYEY SILT	ML	Tan, slightly cohesive, nonplastic; some fine-grained, gravel consisting of angular weathered limestone; slightly moist.
14.0 - 19.0	SANDY SILTY GRAVEL	GM	Varicolored, gravel consists of medium to very coarse weathered limestone, noncohesive, loose, lightly cemented; dry.
19.0 - 23.5	LIMEY CLAY	CL	Light gray, firm, blocky; slightly moist.
23.5 - 25.0	Limestone	---	Light gray, hard, dry.
			At 24.0-25.0 feet, dark gray limey shale.

TOTAL DEPTH OF BOREHOLE: 25 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-29

LITHOLOGIC LOG OF MONITOR WELL HM-125

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0-0.5	GRASS AND TOPSOIL	---	
0.5-18.0	SILTY CLAY/ CLAYEY SILT	CL/ML	Tan, moderately cohesive, moderately plastic; trace fine angular limestone gravel; slightly moist. At 2.0-3.0 feet, fine to medium limestone gravel, 30 percent. At 10.0-18.0 feet, interbedded light gray limey clay.
18.0-19.0	CLAYEY SILT	ML	Tan to orange, slightly cohesive, slightly plastic; trace fine-grained sand; slightly moist.
19.0-25.0	SAND	SP	Tan, very fine- to fine-grained, well sorted, soft; trace silt; slightly moist. At 22 feet, saturated.
25.0-27.0	GRAVELLY SAND	GW	Sand is tan to orange, fine- to coarse-grained, angular, poorly sorted; gravel is varicolored, fine- to coarse-grained consisting of limestone, oyster shell fossils and chert, subangular to well rounded; wet.
27.0-33.0	LIMEY CLAY	CL	Light gray, firm, blocky, highly weathered; some orange oxidation staining; slightly moist.
33.0	CLAYEY SHALE	---	Blue gray, firm, dry.

TOTAL DEPTH OF BOREHOLE: 33.0 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-30

LITHOLOGIC LOG OF MONITOR WELL HM-126

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 4.5	SILTY CLAY	CL	Dark brown (7.5 YR 3/2), moderately cohesive, slightly plastic, sticky; some medium-grained subrounded limestone; some fine-grained friable caliche nodule.
4.5 - 9.0	CLAYEY SILT	ML	Very dark brown (10 YR 3/2), slightly cohesive, nonplastic; trace fine-grained chert gravel; slightly moist.
9.0 - 17.0	CLAYEY GRAVELLY SILT	GC-GM	Brownish yellow (10 YR 6/6), slightly cohesive, nonplastic; gravel is fine- to coarse-grained weathered limestone, angular to subrounded, 40 to 50 percent.
			At 17.0 feet, saturated.
17.0 - 32.0	SILTY SAND	SM	Reddish yellow (5 YR 6/6), very fine-grained, well sorted; silt is slightly cohesive; trace clay; wet.
32.0 - 36.0	SAND	SP	Reddish yellow (5 YR 6/6), very fine-to fine-grained, well sorted; trace silt.
			At 35.5-36.0, coarser sand.
36.0 - 37.0	SANDY GRAVEL	SW	Varicolored, fine- to coarse-grained, angular to subrounded weathered limestone, oyster fossils and chert nodules.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-30 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-126

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
37.0	LIMESTONE	---	Light gray (N 6 to N 7), weathered, hard; dry.

TOTAL DEPTH OF BOREHOLE: 37 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE B-31

LITHOLOGIC LOG OF MONITOR WELL HM-127

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	GRASS AND TOPSOIL	---	
0.5 - 2.0	CLAYEY SILT	ML	Reddish brown (5 YR 4/4), moderately cohesive, slightly plastic; some weathered fine to medium limestone gravel; slightly moist.
2.0 - 3.0	LIMEY CLAYEY SILT WITH GRAVEL	GC	Silt is yellowish red (5 YR 4/6); limey clay is white (5 YR 8/1), silt and clay is slightly cohesive; gravel is medium to coarse-grained, angular to subangular weathered limestone; slightly moist.
3.0 - 11.0	GRAVELLY CLAYEY SILT	GC	Reddish yellow (7/5 YR 6/8), slightly cohesive, nonplastic; gravel is fine- to coarse-grained, angular to subrounded weathered limestone; slightly moist.
11.0 - 20.0	GRAVELLY SILT	GM	Pink to reddish yellow (7.5 YR 7/4 to 7.5 YR 7/4), noncohesive; gravel is fine- to coarse-grained, angular to subrounded weathered limestone; trace cobbles of limestone; dry. At 15.0-16.0 feet, same as 3.0-11.0 feet.
20.0 - 25.0	CLAYEY SILT/ SILTY CLAY	ML/CL	Strong brown (7.5 YR 5/6). At 20.0-24.0 feet, 30 percent recovery, noncohesive, slightly moist. At 24.0-25.0 feet, more clay, slightly cohesive, firm, blocky, slightly moist. At 25 feet, saturated.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE B-31 (continued)
LITHOLOGIC LOG OF MONITOR WELL HM-127

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
25.0 - 36.0	SAND	SP	Reddish yellow (7/5 YR 6/8), very fine- to fine-grained, well sorted; saturated. At 29.0-34.0 feet, no recovery from core sampler, probably sand slurry.
36.0 - 38.5	GRAVELLY SAND	GM	Reddish yellow (7.5 YR 6/8), sand is fine- to coarse-grained, poorly sorted; gravel is fine- to medium-grained, subangular to subrounded; trace coarse gravel consisting of weathered limestone, chert, and oyster fossils.
38.5	FOSSILIFEROUS LIMESTONE	---	Gray (N 6), hard, dense; fossils are oyster shells, few and well cemented within limestone.

TOTAL DEPTH OF BOREHOLE: 38.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

APPENDIX C

SEISMIC STUDY, GENERAL DYNAMICS, FORT WORTH DIVISION, WINDOW AREA

SEISMIC STUDY
GENERAL DYNAMICS
FORT WORTH DIVISION
WINDOW AREA

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CONTENTS

INTRODUCTION

A seismic survey is a non-invasive, albeit indirect, geophysical method used to develop information about subsurface geometry, depths, and velocities. In the case of this General Dynamics Fort Worth Plant project, the seismic study focused on the near surface stratigraphy as it may affect groundwater conditions. The objectives were targets which would provide information concerning water, confining layers, and relationships between aquifers. These included the water saturation level in the "Upper-Zone" (a general term referring to material overlying the Walnut Formation), the "Upper Zone" base--the Walnut Formation (referred to often in the literature as the Walnut Clay, but described here as a "fossiliferous limestone"), and the Paluxy Sand (which includes a variety of sands, clays, carbonates and siliceous zones). Specifically, the objectives involved water levels, thickness of the "upper zone", depth to the Walnut surface, thickness of the Walnut, and layers within the Paluxy.

The study began with a series of 10 test shots on September 11, 1987, to examine the feasibility of shooting through asphalt, between a concrete sidewalk and a rock-lined drainage ditch, and on a grass area subject to the interference of nearby jet engine noise. This work was followed by a planning meeting on October 8, where Hargis personel laid out a series of seismic lines and determined priorities for the surveys. The field work was accomplished in two phases beginning on October 11 and continuing on October 25. To date, the study involves more than 7200' of seismic data, not including the 10 test shots. The primary objective has been to provide information concerning a channel, or "window", in the Walnut which appears to serve as a path for contaminants to move from west to east across the plant site. In addition, the data has been interpreted in terms of other intermediate hosts and paths for contaminants. It is interesting to note that the "window" originally discovered by the Corps of Engineers borings would be similar tin character to the erosional surface described in by the topographic map of the pre-built plant site area.

This report begins with a discussion of the reflectors involved, then describes the interpretation procedure using the soil boring data. This is followed with a line by line dscussion of the seismic data. We conclude with discussion of possible scenarios for contaminant movement in light of the seismic data.

SEISMIC OBJECTIVES

Refractions and reflections both depend upon contrasts in velocity and density,

whose product is referred to as acoustic impedance. The two typically increase naturally with depth. When this is the case, the refraction raypath tends always in the same sense and the reflection phase is always the same. However, in groundwater situations involving sands interlayered with higher velocity materials, contrasts do not always increase monotonically and "blind zone" and reversed phase situations result. The section at the General Dynamics Fort Worth facility includes sands which may present such inverse contrasts.

The first velocity-density contrast in the section at the General Dynamics site is that between
the unsaturated near surface material and the water saturated zone. The initial refraction work on Grant's Lane identified the first refractor at 28' depth which correlated with measured water level in the "Upper Zone" at that location. The first reflector, then, was correlated with the "Upper Zone" water level and identified on each reflection section. This appears to control the refraction return and the refraction depth calculations are included in the comments on each line.

Other candidates for very shallow events would be local deposits within the "Upper Zone", above the Walnut surface. The soil borings on the grass area between the apron and the runway encountered gravels, for example, and several records have been interpreted to include a gravel surface in the preliminary edition of this report. Discussions with Mr. Luke Gilpin of General Dynamics indicate that these gravels may play an important role in the "Upper Zone" groundwater regime. This possibility is discussed at the conclusion of this report.

The Walnut Formation-as a fossiliferous limestone-was expected to exhibit a marked positive impedance contrast and serve as a strong continuous reflector. Discussion with Mr. Sam Williams of Hargis+Associates and uniformity of Corps of Engineers borings to refusal supported this expectation. Subsequent correlation with events on Line B9-B21 indicate that this is so.

The Paluxy Formation, a sand immediately beneath the higher impedance Walnut, was a problematical pick in that it might present a reverse phase reflection. Discussion with Mr. Gilpin indicate that the borings for the new monitor wells on Grant's Lane encountered several reflection candidates within the Paluxy--such as a carbonate stringer and a siliceous zone. The e-logs of these borings support this possibility in that the reflector candidates may be correlated from one to the next.

DATA ACQUISITION

The seismic reflection technique has long been the staple of oil and gas exploration. Recently, advances in microprocessor technology have made the method appropriate for shallow stratigraphic studies. Refraction surveys have been used in

engineering applications routinely for a number of years. In this study, we combined reflection and refraction shooting. Each line segment consisted of two refraction shots, one from each end of the line, and 12 near trace reflection shots.

The initial tests indicated that we should shoot our reflection records as close to the recording trace as practical. It was also obvious from these tests that low-cut filtering at 300 hz or more would reject a good deal of the ground roll.

The data acquisition parameters are summarized in outline form for brevity:
The instrumentation used in this study included:

Seismograph: Geometrics ES1225 12 Channel Digital System

Geophones: Geosource 28hz

Field recording: Apple IIc to disc

Field Parameters:

Refraction: 20' shotpoint offset, 20' interval, 240' spread, no filter

Reflection: 20' shotpoint offset, 20' trace spacing, 300hz low cut analog filter at input

Data Processing

Processing: Apple with Canadian Geological Survey software

Processing involved a variety of gain tapers, trace gain normalization, filter, and individual trace gains

Refraction Procedure

Buffalo gun source, open end filter, off-end reversed shots

Event picking using an interactive computer program

XT velocity and intercept time calculations

Reflection Procedure

Buffalo gun source, 300 hz low cut filter, near trace "beneath" window at 20' offset, freeze channel option used to develop common offset sections which were then processed and printed

INTERPRETATION PROCEDURE

Each record was examined onscreen using a simple plot program. Events were picked and the resulting sections plotted for preliminary analysis. The next step involved processing the records on a given line using a common-offset processing program developed by the Canadian Geological Survey. Each line was processed several times to optimize the gain tapers, trace gain normalization window, filter, and to reduce high amplitude traces. The resulting records were then plotted as time sections. An interesting exercise for the reader would be to hold the section almost

parallel to the eyepath to correlate the "wiggles" from trace to trace.

Once the records were processed, the next step was to correlate the reflection events with geologic information. Often this is a qualitative process. In the General Dynamics case, however, soil borings were drilled along a profile shot as our Line B9-21 following our first field session. These boring provided a thorough picture of the section of interest in that six of the fifteen penetrated the Walnut and extended well into the Paluxy. The soil boring notes for the line of bores along the runway were plotted as logs (see attached section and boring log records) and correlated in a boring cross-section. The reflector tentatively interpreted as the Walnut was assigned to a proportionate position on the RSB 1 (=HM95) log. This interpretation was tested by checking the same proportion on the log closest to the north end of the line. The result is shown on the set of sections titled: Correlation Section. The uppermost section is the seismic section with events interpreted and soil boring logs placed in locations for correlation. Note the features interpreted as the water saturation surface, the Walnut, and the Paluxy. The middle diagram is a time section drawn as an interpretive overlay on the seismic section. Here, the same logs are shown for correlation. The overlay shown below the seismic section is a plot of the interpreted reflections. The legend is depicted in time, and in terms of the correlation, also in converted depth. The lowermost section shows the complete boring log section for correlation with the two sections above.

It is interesting at this point to note some additional features that may be interpreted on this line. One is the apparent pair of 'highs' on the upper reflector at the north end of the B9-21 profile.

This feature is found on several profiles and may represent a higher water level due to leaks or septic outfall. The situation is probably ephemeral. A second feature is a lower amplitude, higher frequency reflection that correlates with the gravel indicated by the boring logs at the north end of the section. The soil boring logs indicate that the gravel is not uniform from the channel to the south.

Note that this procedure is subject to the limitations described and the interpretation is subject to change as later information becomes available. In each case the seismic section is presented with annotated interpretation and then with an overlay section immediately below.

SEISMIC LINES

Refer to the line location map and the associated figures. The features discussed above will be reviewed in terms of their trends on specific lines.

Line A: This line was shot on Grant's Lane between the sidewalk and the drain culvert. Field conditions were difficult and the best records were obtained on

Sundays during time of low traffic. Ice tripods were used where recording crossed pavement. Explosives were used in all but a few locations. The records show a lot of high amplitude low frequencies that continued to dominate the record after filtering. The records show a very shallow event that we associate with the water table. Refraction calculations show the surface at 28' with a 3400'/sec velocity material beneath. The reflection effect is greatly diminished in the vicinity of the end of WA3 where the tunnel and utilities cross. There is a deeper reflector at about 26 ms which correlates with the Walnut. The high frequencies mask the reflectors across much of the section. This makes correlation with the boring logs difficult in the vicinity of the rise out of the 'channel' shown on the cross-section. The comparison here is approximate due to the scale difference between the boring section and the seismic time section.

Line B: This line has two legs as shown on the map. WB3-6 is a cross line which shows the shallow reflector, interpreted as the water saturated zone, at about 16ms with some shallower "mounding" which may indicate shallower saturated ground. The refraction data shows a shallow refractor at less than 20' in this area. The deeper reflectors appear to drop near the runway, but this is a static artifact. The interpreted Walnut reflector occurs at about 25 ms and shows a low about mid profile. This low is also seen on the interpreted Paluxy below. The second leg of WB parallels the flight line and incorporates the Hargis borings as shown. Note again that the shallow reflector shows several mounds which may be associated with local water sources. The water level rises in a general way to the north. The Walnut reflector appears to drop off at the north end. This is north of the northernmost Hargis boring in this cluster, but drops in the sense shown in the next Hargis boring to the north which appears to the right of the line. The log of RSB 1 (=HM95) is attached to the left and the log of RSB 8 is attached to the right of the seismic section. Arrows depict the Walnut surface as a reflection example. Note the reflector above the Walnut which correlates with the gravel described on the boring. The Paluxy reflector seems to follow the drop of the Walnut surface, but not at the steep dip.

Line E: This line is parallel to the runway and midway between the flight line and the runway, ie. parallel to Line B and east of it. It is also offset to the north. The water saturation reflector shows a mound in the vicinity of the outfall line in the center of the grassy area. The refraction values show a 3200'/sec material at 28' near the mid point of this profile. The south end of this line may be matched with the north end of line WB. Note that while the reflection we are associating with the Paluxy may be interpreted to drop near the north end. the Walnut appears to show a low to the south of this.. A deeper reflector is also shown but is not within the vertical section of

interest.

Line F is again parallel to the runway and almost too close. It is enechelon to line WE. We had originally interpreted the Walnut reflector as shallowing in this area, but this now appears not to be the case. Again, the Walnut reflector shows a low of about the same dimension as that shown on Line E.

Line G is a diagonal cross line and matches with WE and WF. Note the drop in the Walnut surface from right to left. We have interpreted a gravel at this end in which is near the boring shown on the Hargis line.

Line H is another diagonal cross line. It is offset 200' to the north of Line G. Here the Walnut is interpreted to drop somewhat less at the apron end.

Line D: This is a cross line parallel to Line B3-6. Here the intermediate reflector is rather flat but shows a slight low. These more subtle lows on all lines should be examined in detail as more geologic information becomes available.

COMMENTS ON REFLECTOR TRENDS AND FUTURE STUDIES

Paluxy-The reflection interpreted as related to the Paluxy top or a reflector within the upper part of it is a prominent event on the sections. Future work should define just what this reflector is. It may be a continuous feature related to one of the clays or other potentially sealing zones. The e-logs of monitor wells penetrating the Paluxy were not available until after the seismic field work was completed. The logs and boring information describe the stratigraphy in detail. It appears that there are several candidates for reflectors within the upper part of the Paluxy. It would be important to do a velocity survey in one of the RSB wells completed as a monitor in order to tie these reflections.

Walnut-The interpretations at this point have been oriented toward the channel or "window". Features associated with small scale variations such as deposits or smaller channels may be also be examined. For example, the south end of Line B shows a slight low in the Walnut. Similar features may be observed on other lines. The original data sections allow the reader to review these features as new geologic information becomes available.

Gravel-The gravel interpreted at the north end of Line B in our earlier report was identified on the basis of the reflector position relative to a channel and the presence of the gravel in the boring. Note that no gravels are described in the logs provided to us from studies prior to the RSB line. The RSB logs describe both a gravel and a gravelly sand. The HM well with the high concentration of contaminant appears to be associated with such a gravelly sand.

Water Level-The interpreted water level appears to drop in a general way from west to

east (compare Line B with Linc F). There are also local "mounds" and other high areas that seem to correlate with surface sources of water such as water lines and septic outfall areas (note the north end of Line E and the centers of Lines D and B).

One possible scenario for groundwater movement relating the seismic reflection measurements, water, and gravel data might involve local sources of water flushing high contaminant concentrations and leaving residuals in areas of lower recharge. That is, the high concentration found at HM95 (=RSB1) shown at the south end of the correlation profile is also an area where the water level is low. At the north end, in the "channel" area, the concentration is lower and the water level shown on the seismic record is higher suggesting that local recharge of the "Upper Zone" in this area could dilute concentrations. There are sources of recharge apparent in this area.

We are very interested in continuing these measurements and will be available for discussion during the coming weeks to participate in project planning. The list below is an example of what we feel future seismic work should include:

1.Completion of Line B to the north to include the rest of the RSB borings.

2.Cross lines on the north end of the grass area.

3.A series of lines on the grass areas to the east and to the south. These lines should be interpreted in terms channels as well as more subtle features which would serve as targets for further study.

4.Velocity surveys at cased monitor wells to provide additional depth control. We would also like to measure velocities directly on outcrops near the lake.

Please call if you have any questions concerning this report. We appreciate the cooperation and interest of all concerned and look forward to providing additional seismic measurements.

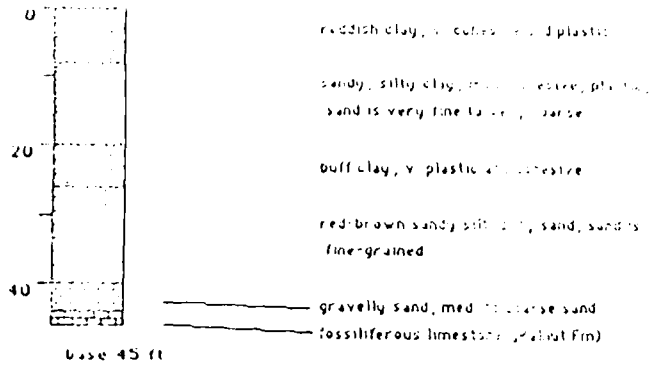
APPENDIX A

	1	2	3	4	5	6	7	8
1	GENERAL DYNAMICS FORT WORTH WINDOW PROJECT							
2	SEISMIC INVESTIGATION WORKSHEET							
3		ARCH	SHOOT	REFR/				
4	LINE	DISC	DATE	REFL	NOTES	PROCESS	PRESS	SEISPAC
5	WA1	1	OCT11		concret			
6	WA2	1	OCT11		concret			
7	WA3	1	OCT11	R	40hzfil	fil	csection	y
8	WA4	1	OCT11		conc			
9	WA5	1	OCT11	R	40 hzfil	not 6///	csection	y
10	WA6	1.	OCT11		conc			
11	WA8	2	Oct 25		conc			
12	WA9	2	Oct 25					
13	WA10	2	Oct 25	R	300fil	new filter	cgs	
14	WA11	2	Oct 25		conc			
15	WA12	2	Oct 25	R			now rela	
16	WB1A	1	Oct 12		grassy			
17	WB2	1	Oct 12					
18	WB3	3	Oct 12	R	to run	note mnd	section	y
19	WB4	3	Oct 12					
20	WB5	3	Oct 12					
21	WB6	3	Oct 12	R	cross	static end 3	section	y
22	WB7	3	OCT 12		w/bore			
23	WB8	3	OCT 12		w/bore			
24	WB9	4	OCT 12	R	w/bore	apron line	section	y
25	WB10	4	OCT 12		w/bore			
26	WB11	4	OCT 12		w/bore			
27	WB12	4	OCT 12	R	w/bore		section	y
28	WB13	4	OCT 13		w/bore			
29	WB14	4	OCT 13	R	w/bore	chng #	not 15	y
30	WB15	4	OCT 13		w/bore			
31	WB16	4	OCT 13		w/bore			
32	WB17	5	OCT 13		w/bore			
33	WB18	5	OCT 13	R	w/bore		c sect	y
34	WB19	5	OCT 13		w/bore			
35	WB20	5	OCT 13		w/bore			
36	WB21	5	OCT 13	R	w/bore		end b line	y
37	WC1	5	OCT13		cross			
38	WC2	5	OCT13		cross			
39	WC3	5	OCT13	R	cross		cross line	y

	1	2	3	4	5	6	7	8
40	WC4	6	OCT13		cross			
41	WC5	6	OCT13		cross			
42	WC6	6	OCT13	R	cross		cross line	y
43	WD2	6	OCT 14		cross			
44	WD2	6	OCT 14		cross			
45	WD3	6	OCT 14	R	cross		cross line	y
46	WD4	6	OCT 14		cross			
47	WD5	6	OCT 14		cross			
48	WD6	7	OCT 14	R	cross		cross line	y
49	WE1	8	Oct 26					
50	WE2	8	Oct 26					
51	WE3	8	Oct 26	R			c section	y
52	WE4	8	Oct 26					
53	WE5	8	Oct 26					
54	WE6	8	Oct 26	R				y
55	WE7	8	Oct 26					
56	WE8	9	Oct 26					
57	WE9	9	Oct 26	R				y
58	WE10	9	Oct 26					
59	WE11	9	Oct 26	AETREFR				
60	WE12	9	Oct 26	R				y
61	F16	9	Oct 26					
62	WF1	10	Oct 27			well up above slope		y
63	WF1	10	Oct 27					
64	WF3	10	Oct 27	R		plot sec	c section	y
65	WF4	10	Oct 27					
66	WF5	10	Oct 27					
67	WF6	10	Oct 27	R				y
68	WF7	11	Oct 27					
69	WF8	11	Oct 27					
70	WF9R	11	Oct 27	R				y
71	WF10	11	Oct 27					
72	WF11	11	Oct 27					
73	WF12R	11	Oct 27	R			end f line	y
74	W13	11	Oct 27	WF13				
75	W14	11	Oct 27	WF14				
76	WG1	11	Oct 28					
77	WG2	11	Oct 28					
78	WG3	11	Oct 28	R			angle line	

	1	2	3	4	5	6	7	8
79	WG4	11	Oct 28					
80	WG5	11	Oct 28					
81	WG6	11	Oct 28	R				
82	WF15R	12	Oct 27	R				y
83	WF16	12	Oct 27					y
84	WF17	12	Oct 27					y
85	WF18R	12	Oct 27	R				y
86	WH6	12	OCT 28	R				
87	GD10	12	OCT 7			test line		
88	GD10	12	OCT 7			test line		
89	GG6	12	OCT 7			test line		
90	WH1	12	Oct 28				angle line	
91	WH2	12	Oct 28					
92	WH3	12	Oct 28	R				
93	WH4	12	Oct 28					
94	WH5	12	Oct 28					
95	GD	13	Oct7			test line		
96								
97								
98								
99								
100								

RSB 1
(HH 95)



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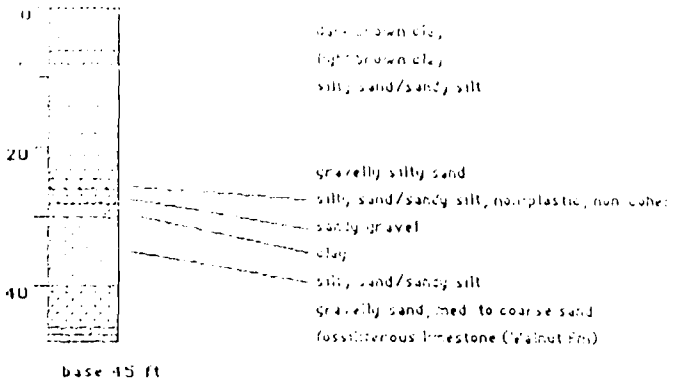

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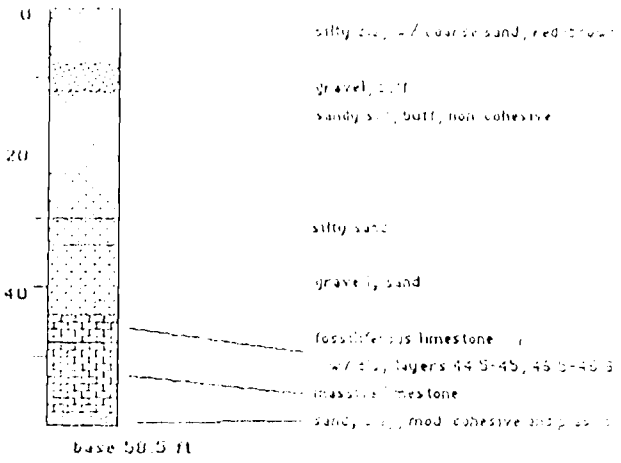

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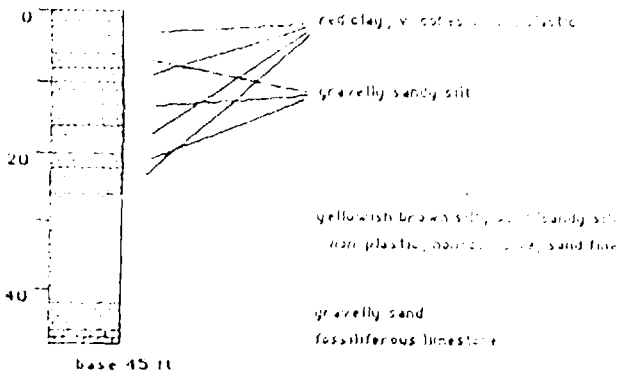

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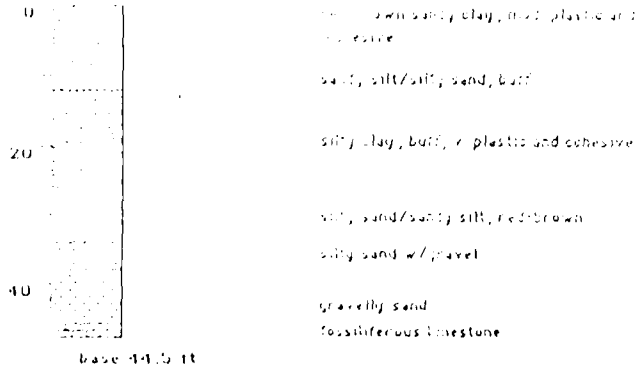

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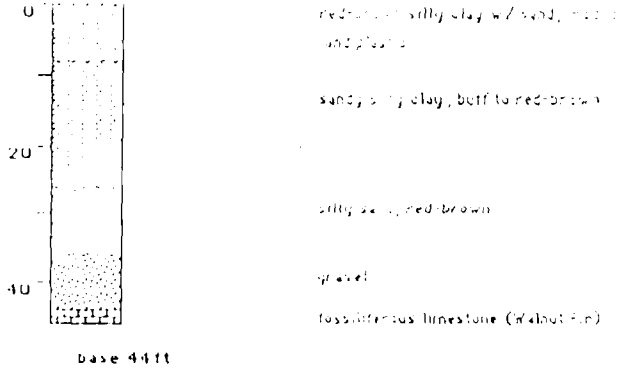

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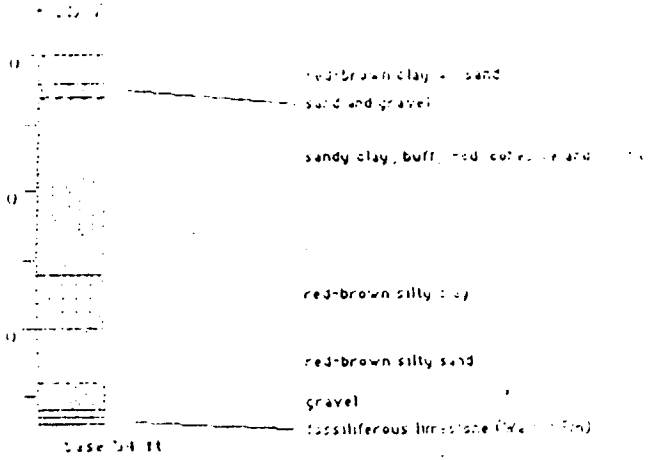
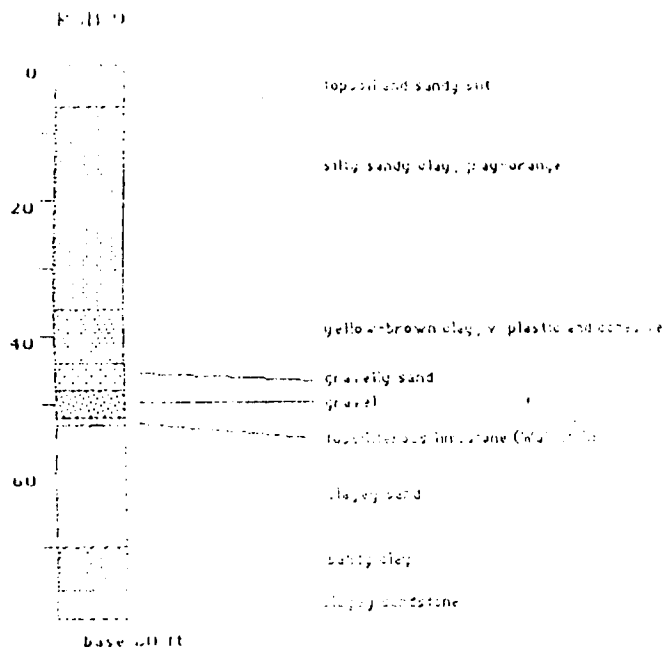
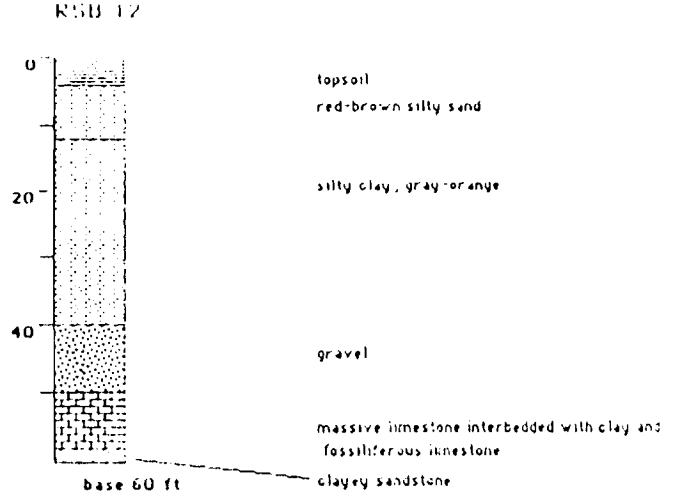
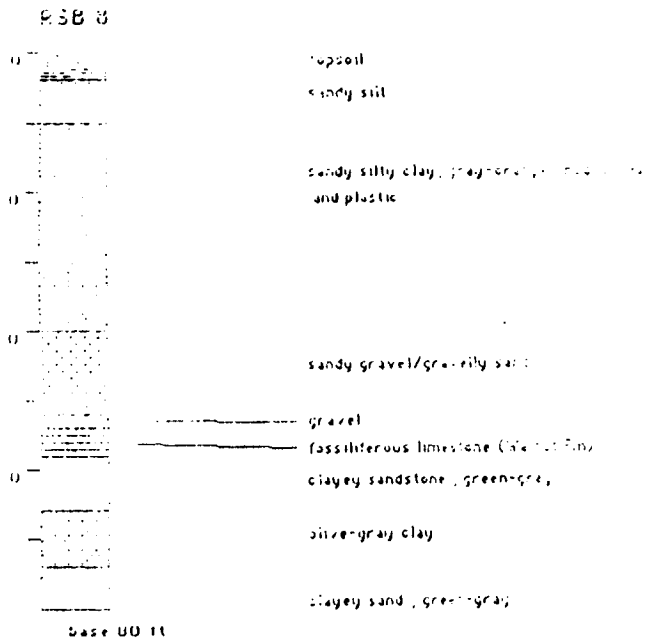
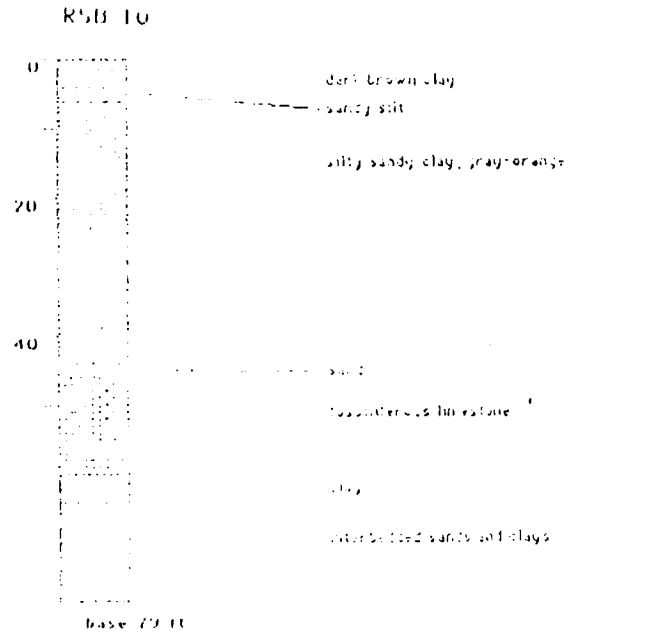
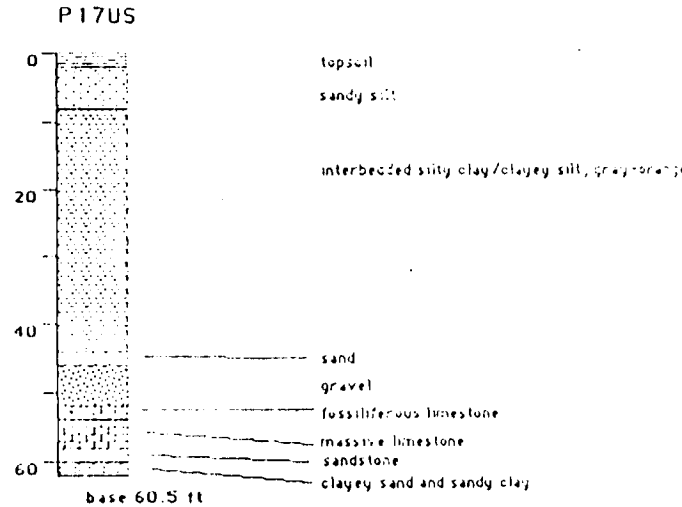

0
20
40
red-brown clay + sand
sand and gravel
sandy clay, buff, red, cohesive and
red-brown silty clay
red-brown silty sand
gravel
fossiliferous limestone (Weathered)
base 54 ft


0
20
40
60
topsoil and sandy silt
silty sandy clay, gray-orange
yellow-brown clay, v plastic and cohesive
gravelly sand
gravel
fossiliferous limestone (Weathered)
clayey sand
sandy clay
clayey sandstone
base 68 ft


RSB 12
0
20
40
60
topsoil
red-brown silty sand
silty clay, gray-orange
gravel
massive limestone interbedded with clay and fossiliferous limestone
clayey sandstone
base 60 ft

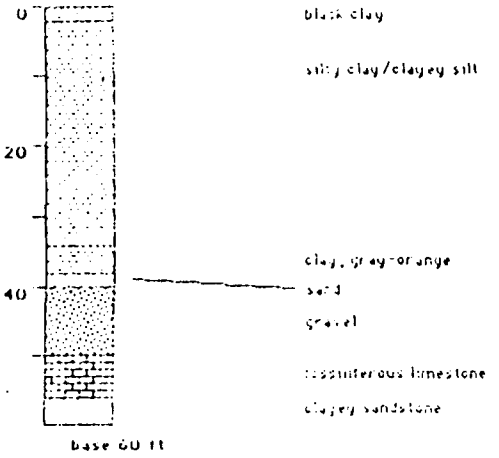

RSB 8
0
topsoil
sandy silt
sandy silty clay, gray-orange, stiff and plastic
sandy gravel/gravelly sand
gravel
fossiliferous limestone (Weathered)
clayey sandstone, green-gray,
olive-gray clay
clayey sand, green-gray
base 80 ft

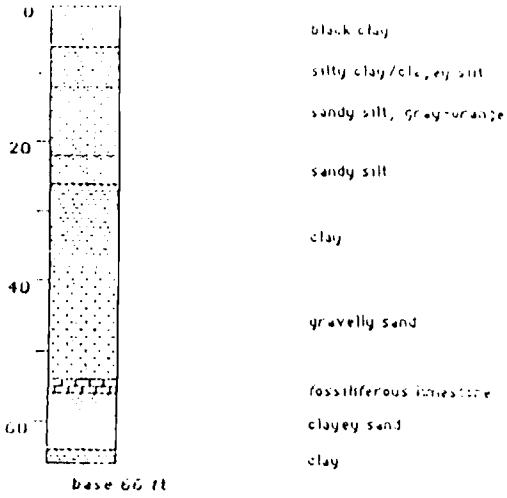

RSB 10
0
20
40
dark brown clay
sandy silt
silty sandy clay, gray-orange
sand
fossiliferous limestone
clay
interbedded sands and clays
base 79 ft


P17US
0
20
40
60
topsoil
sandy silt
interbedded silty clay/clayey silt, gray-orange
sand
gravel
fossiliferous limestone
massive limestone
sandstone
clayey sand and sandy clay
base 60.5 ft

41163

RSB 13





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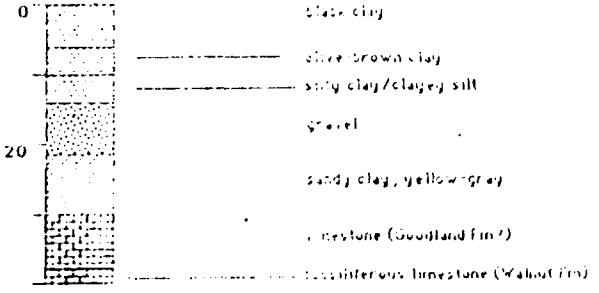
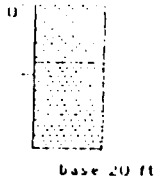


RSB 11



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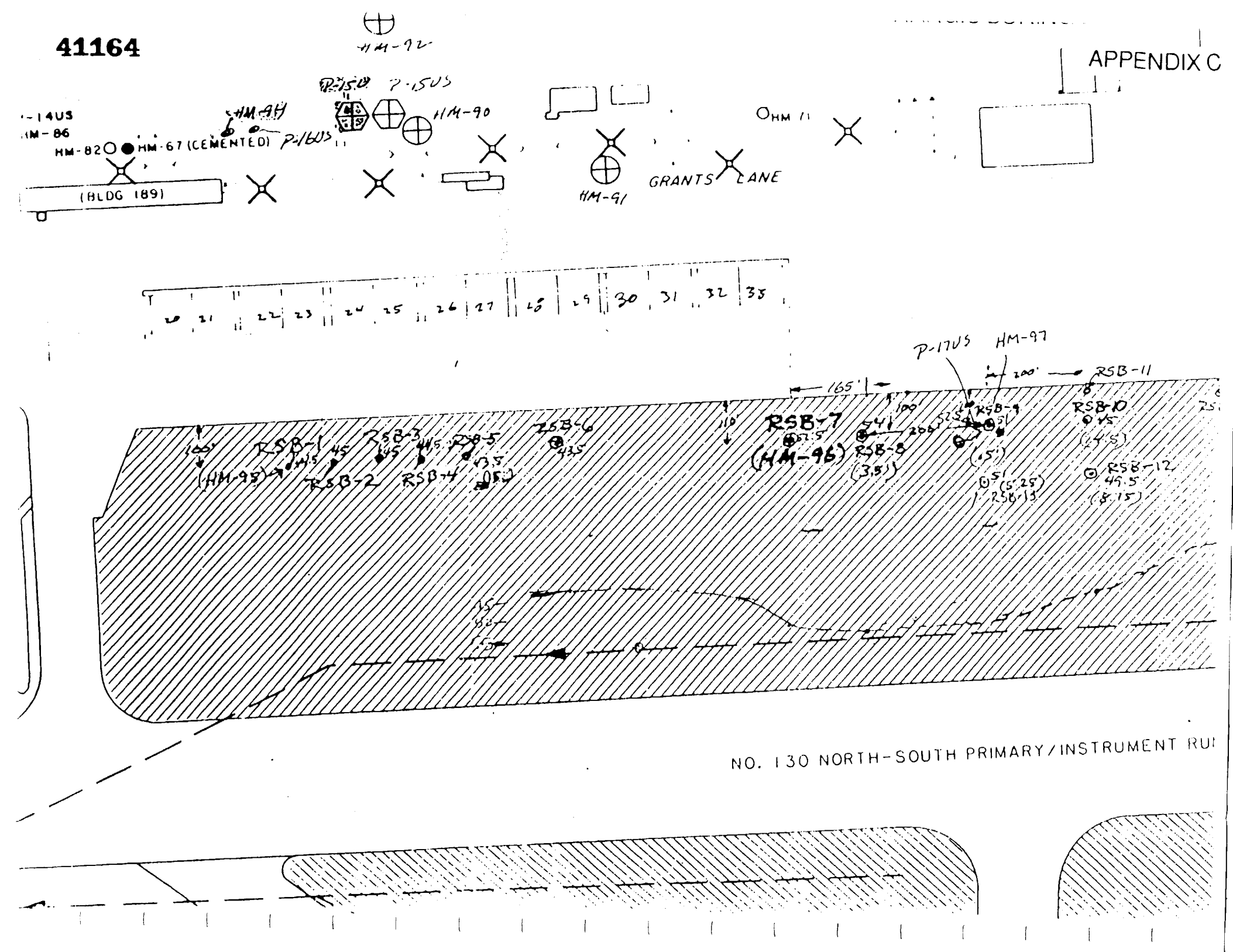
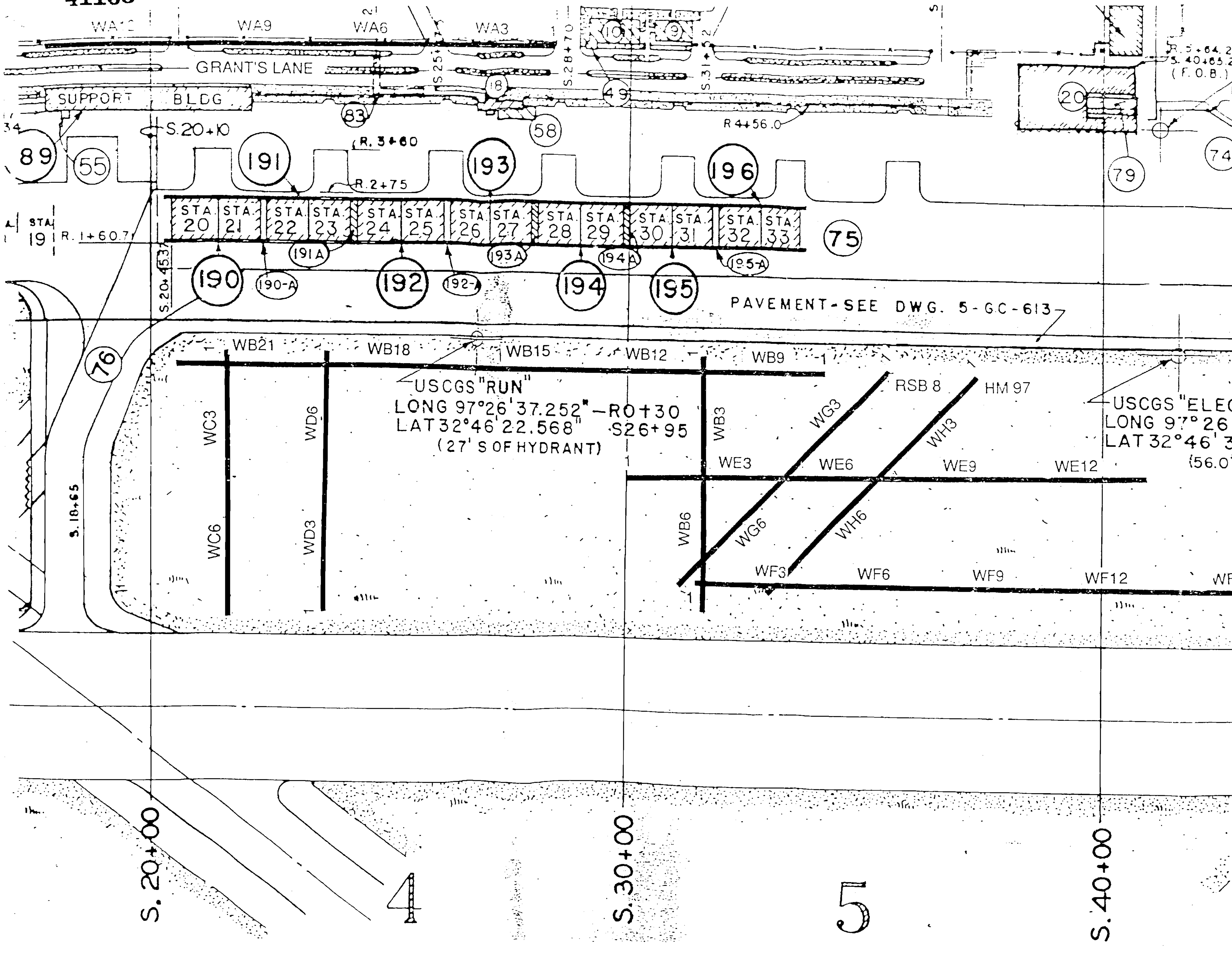
APPENDIX C



41165

FIGURE



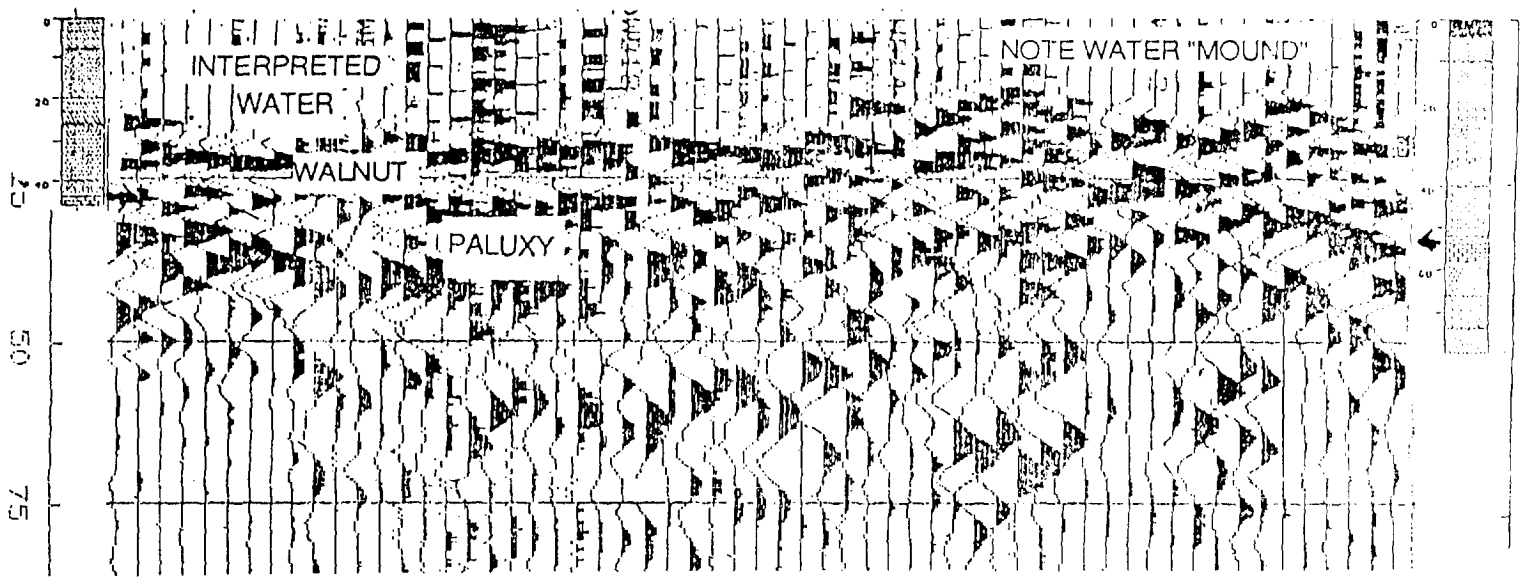
SEISMIC STUDY
LINE LOCATION MAP

GENERAL DYNAMICS
FORT WORTH PLANT
Scale: 1"=200'
NORTH
Note: Each letter refers to a reflection and reversed refraction unit--1 designates initial trace of a profile
November, 1987
H.C. Clark, Houston, Texas

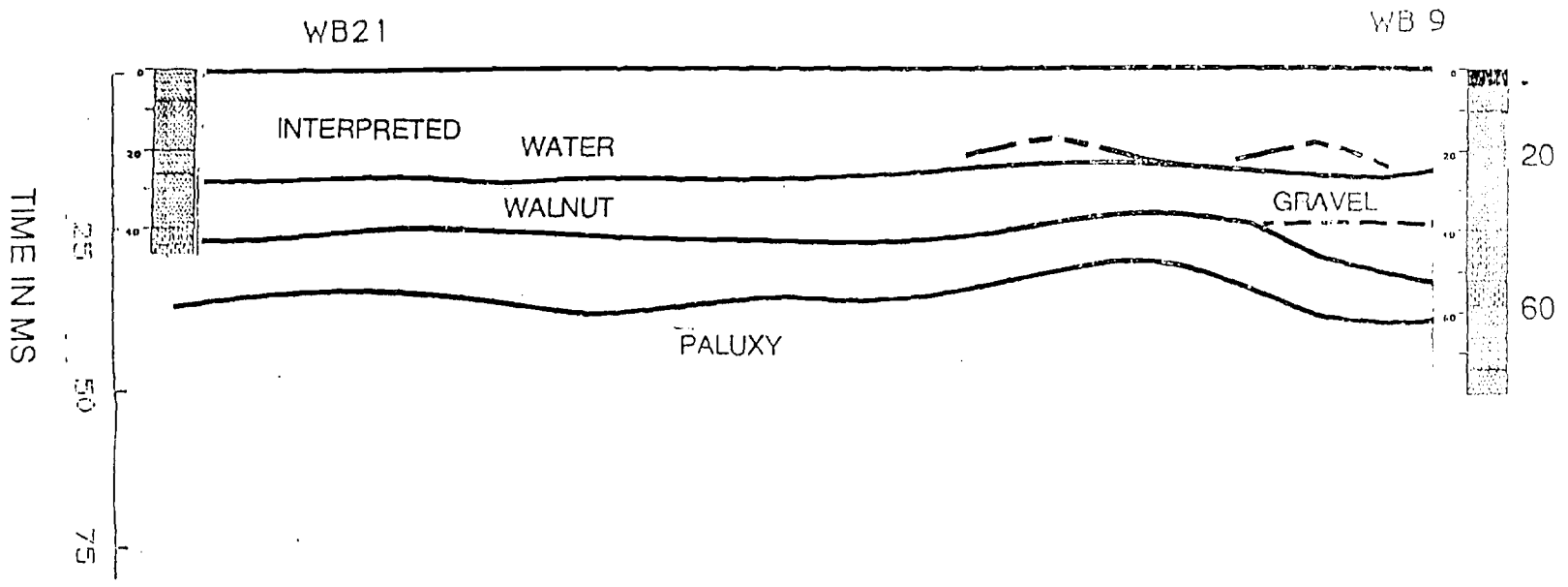
CORRELATION SECTION

FIGURE 2

SEISMIC REFLECTION SECTION



INTERPRETED SEISMIC SECTION

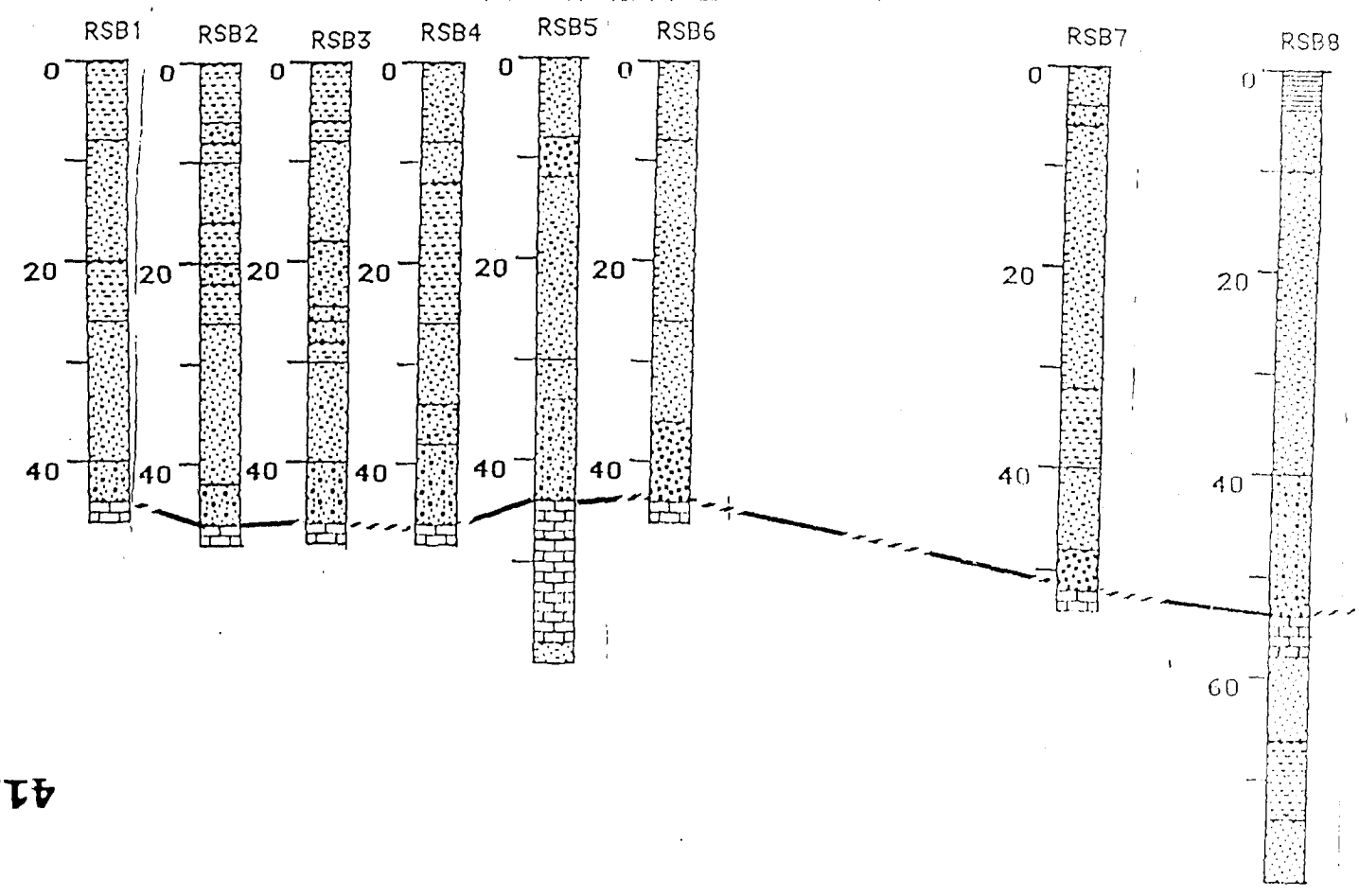


LOGS ARE SHOWN FOR CORRELATION PURPOSES

DEPTH FROM CORRELATION

ACTUAL DEPTH SCALE IS NON LINEAR

BORING LOGS FROM HARGIS FIELD NOTES



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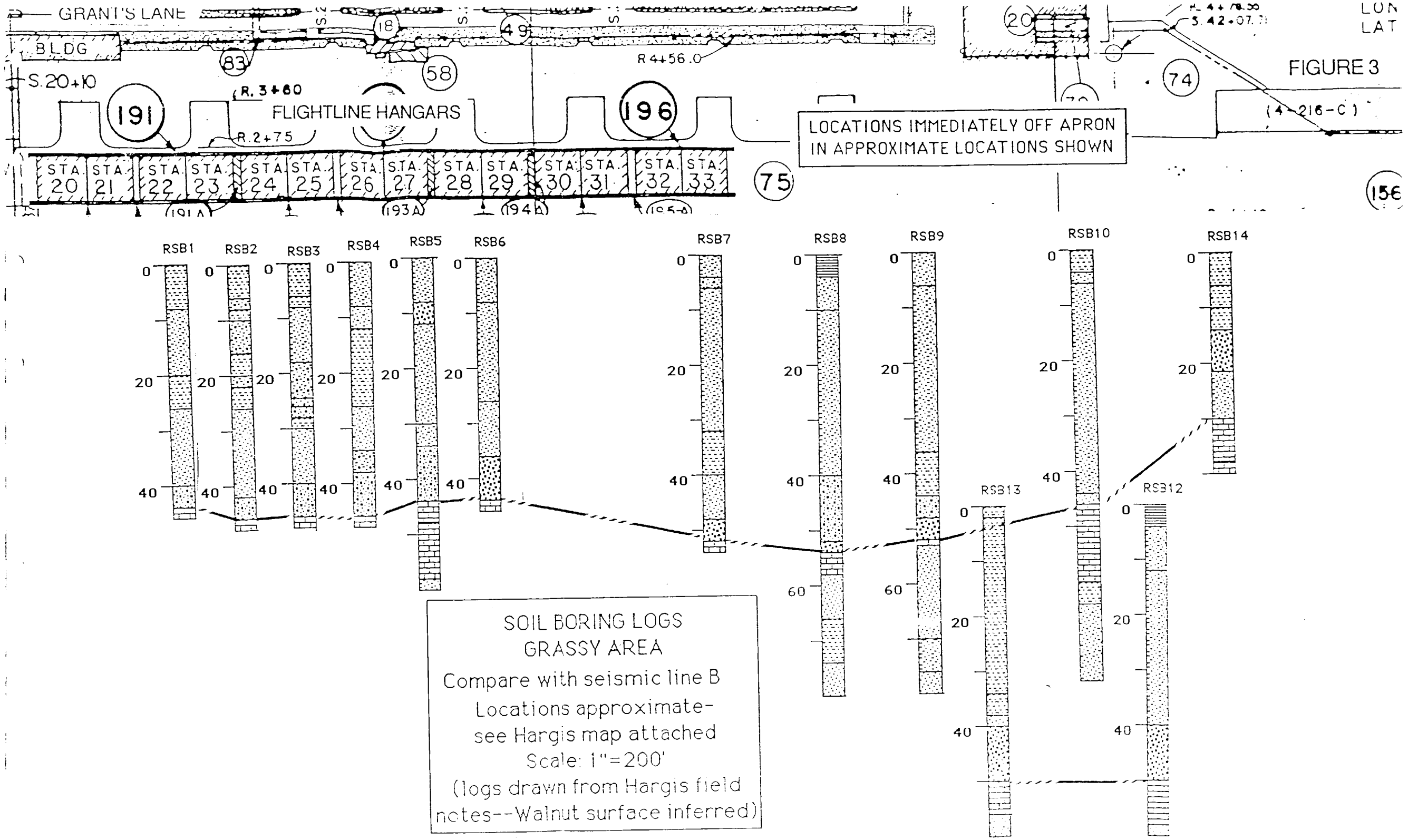

FIGURE 3

SOIL BORING LOGS
GRASSY AREA
Compare with seismic line B
Locations approximate-
see Hargis map attached
Scale: 1"=200'
(logs drawn from Hargis field notes--Walnut surface inferred)

NORTH SOUTH PROFILES

FIGURE 4

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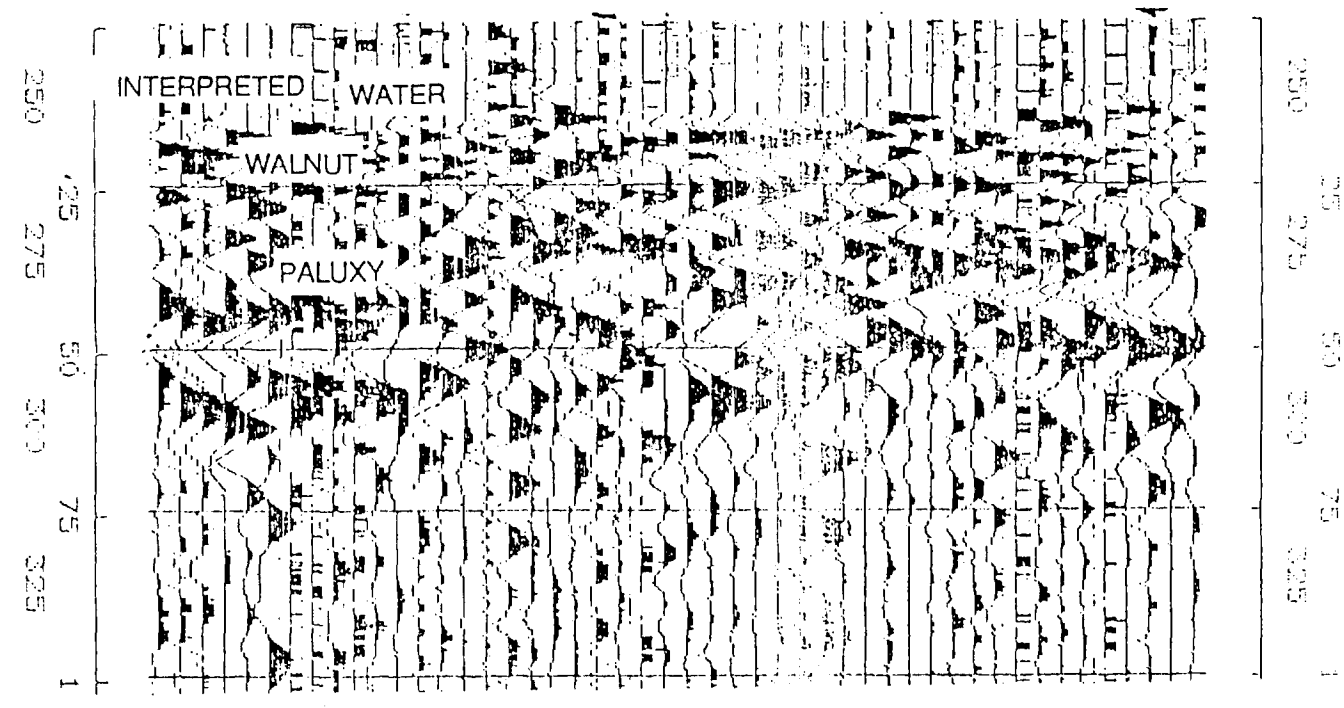
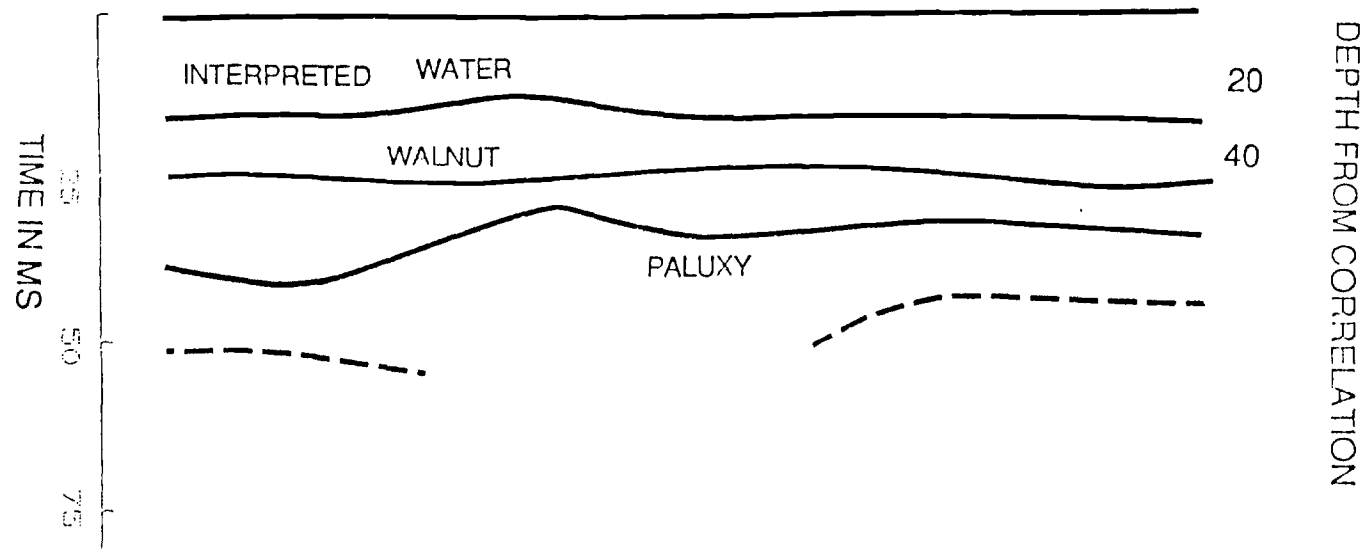
SEISMIC REFLECTION PROFILE

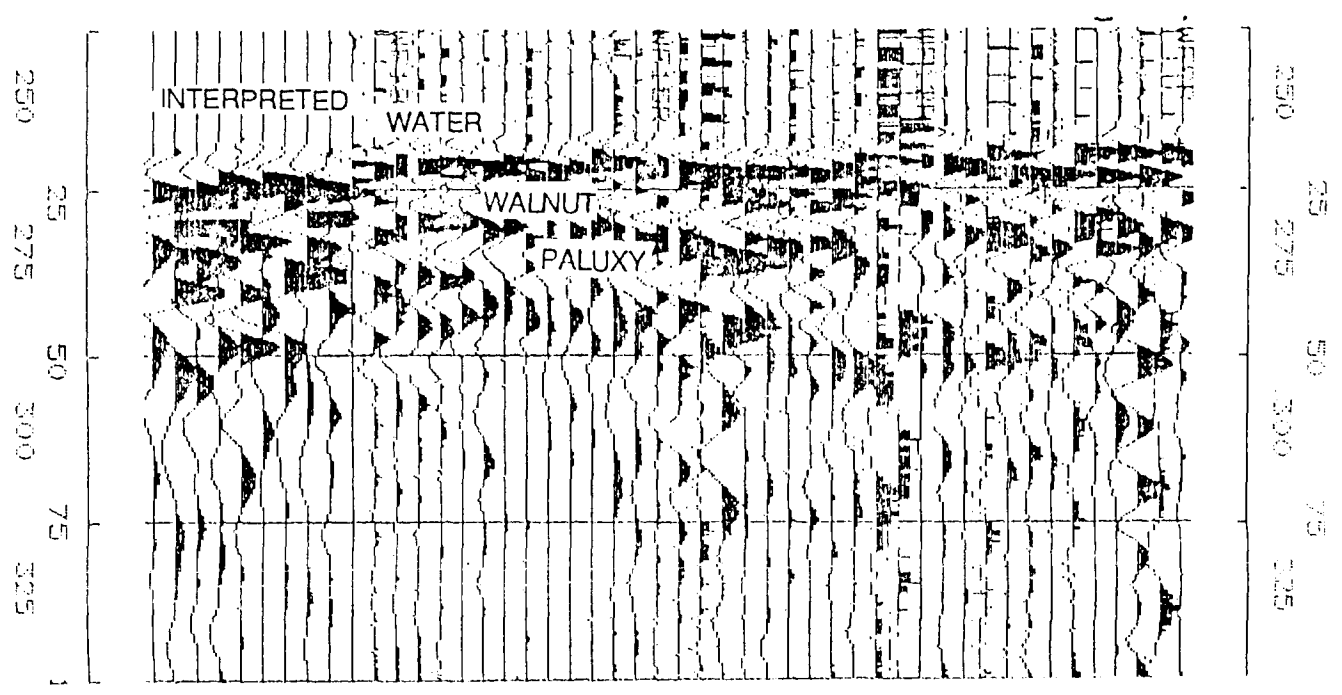


INTERPRETED SEISMIC REFLECTION PROFILE

WE12 WE3

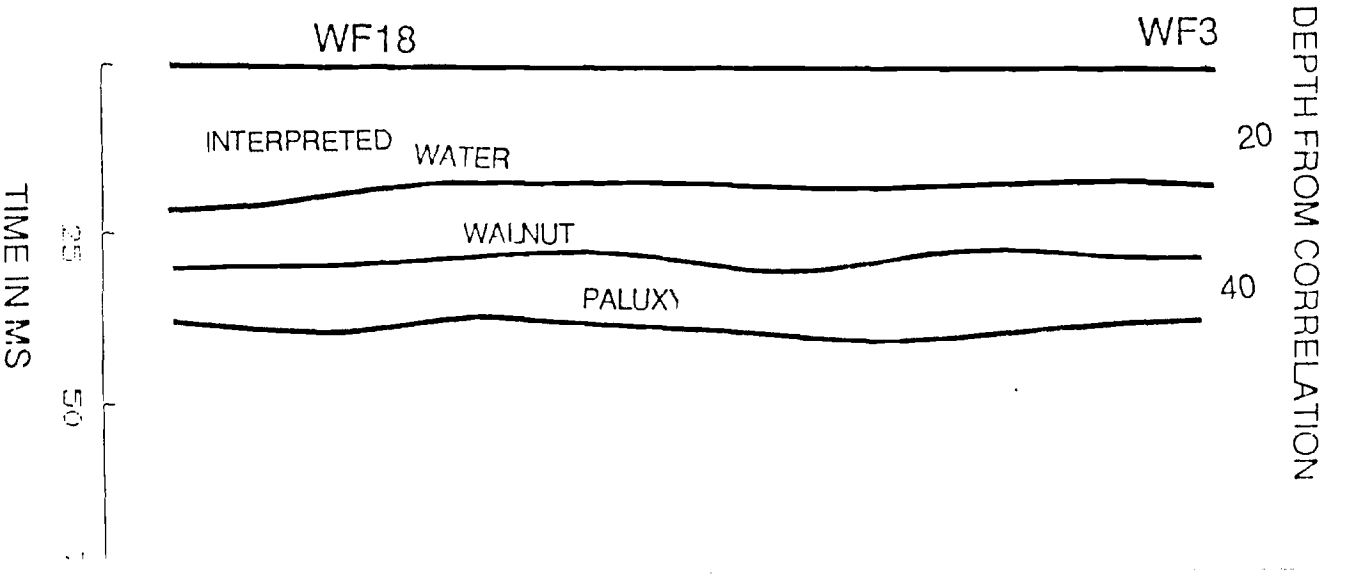


SEISMIC REFLECTION PROFILE



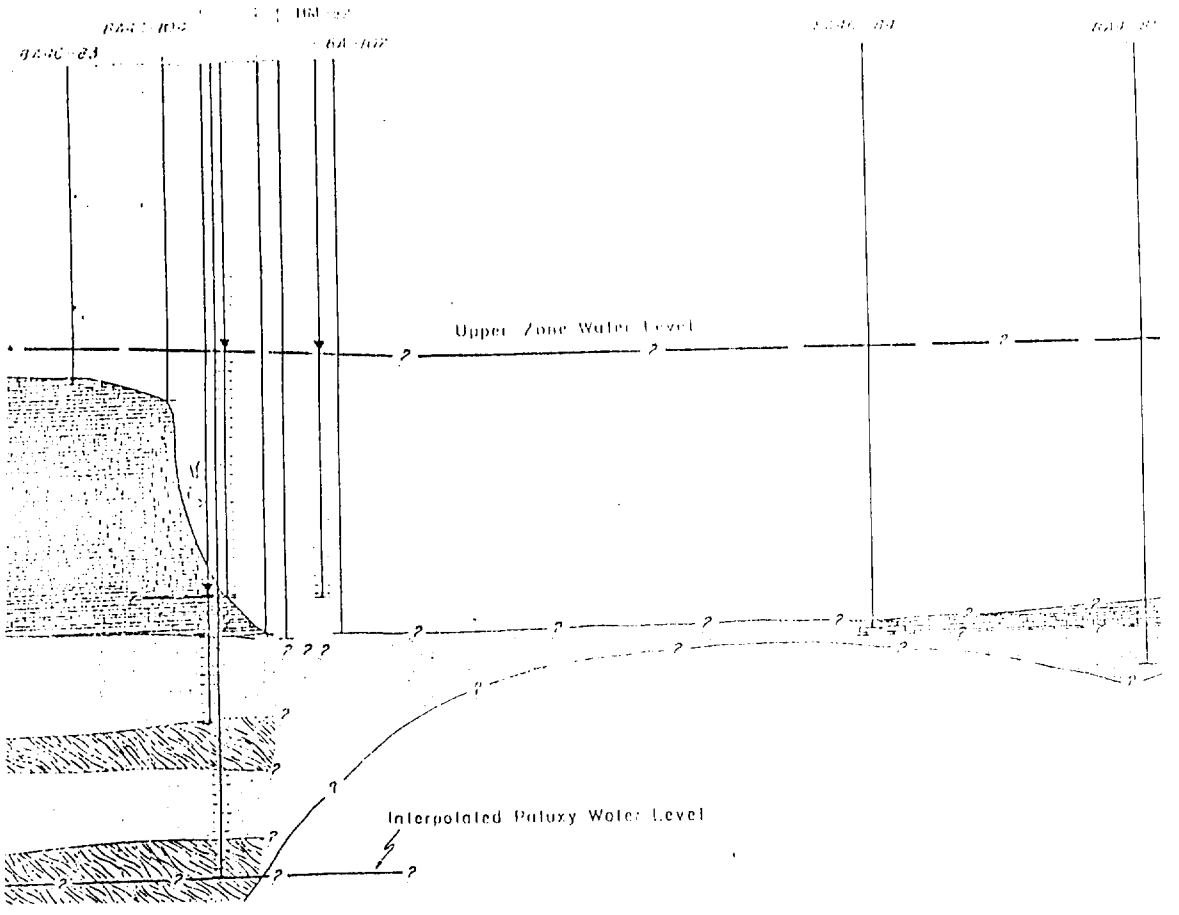
INTERPRETED SEISMIC REFLECTION PROFILE

WF18 WF3

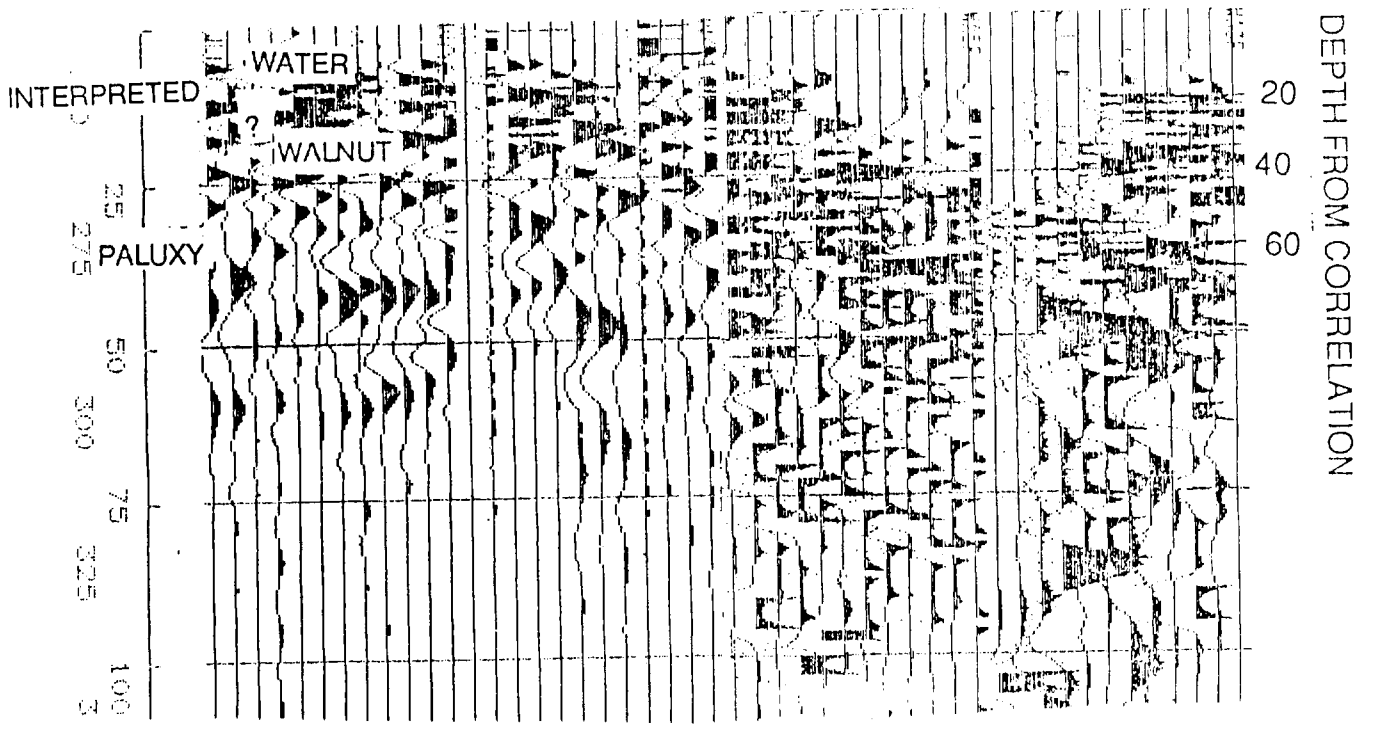


GRANT'S LANE HARGIS PROFILE FROM CORPS OF ENGINEERS AND HARGIS WELL LOGS

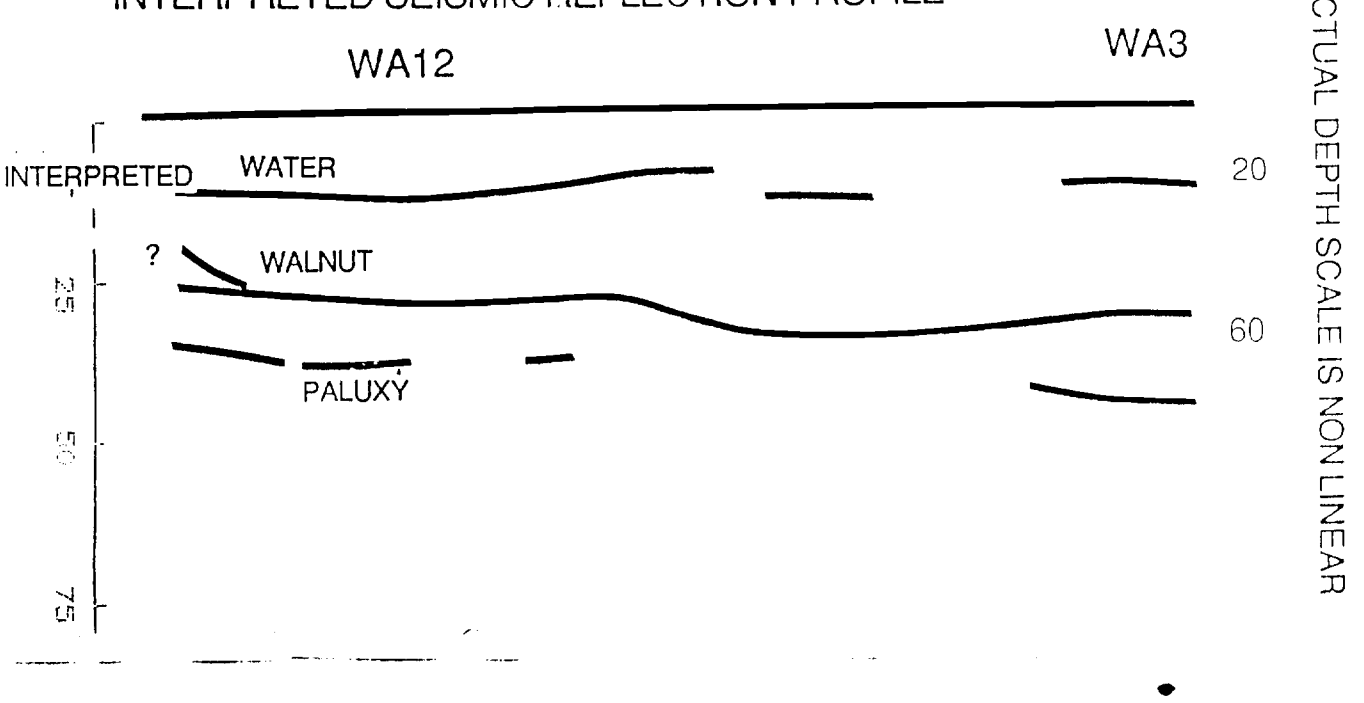
FIGURE 5



SEISMIC REFLECTION PROFILE



INTERPRETED SEISMIC REFLECTION PROFILE



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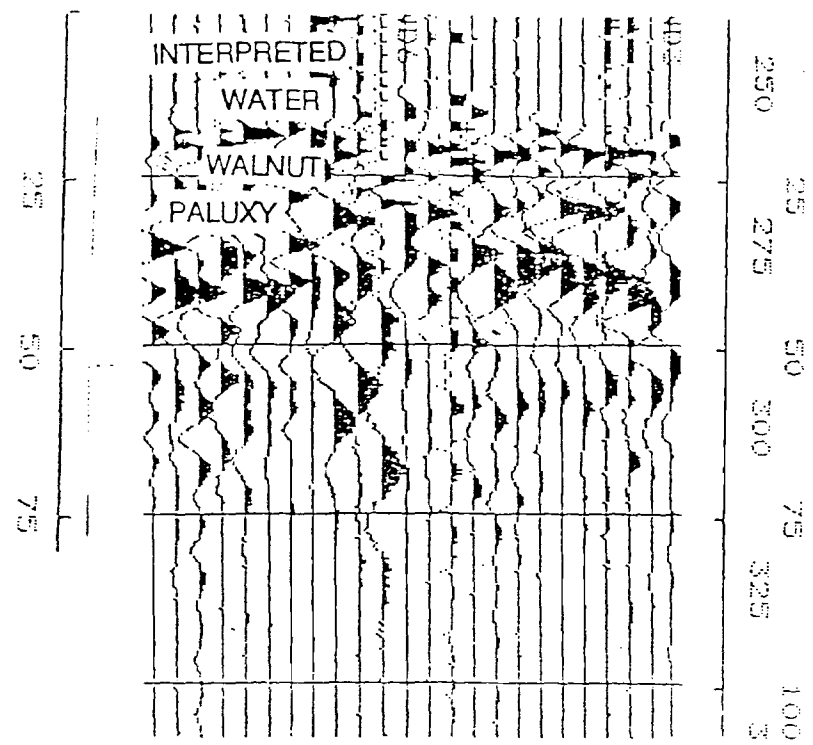
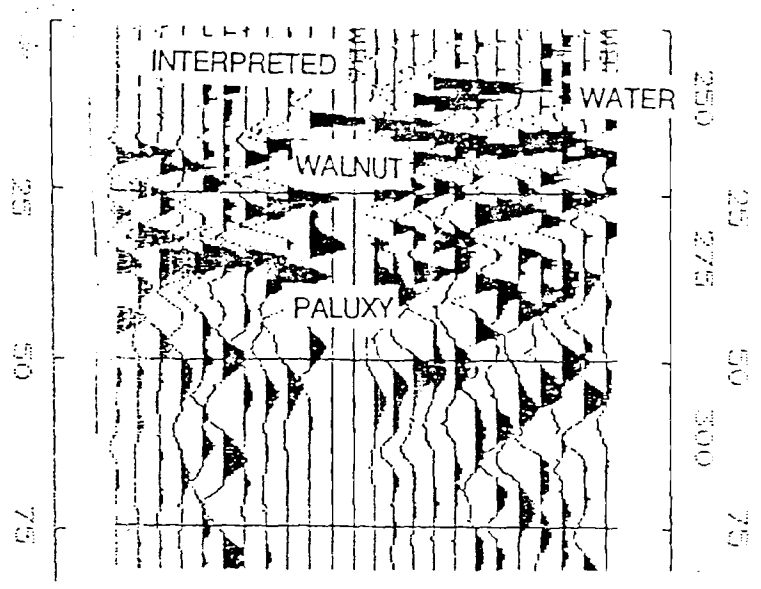
EAST WEST PROFILES

FIGURE 6

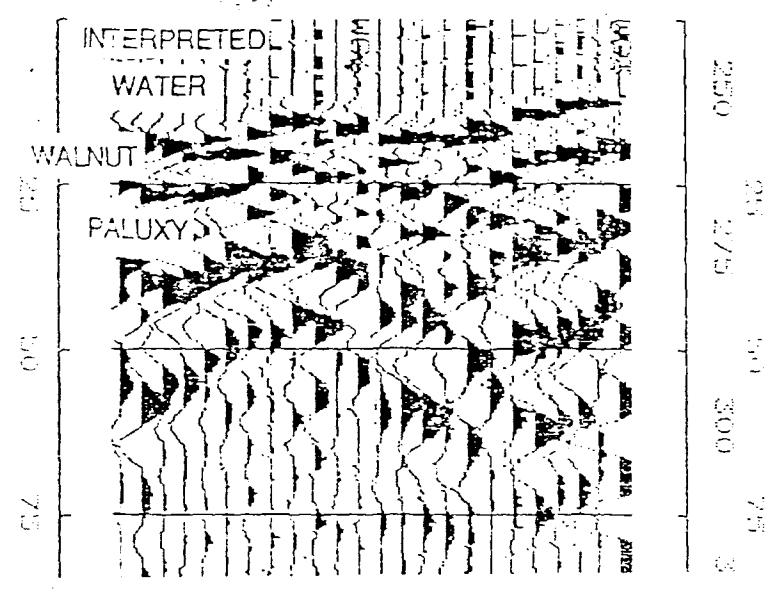
SEISMIC REFLECTION PROFILE



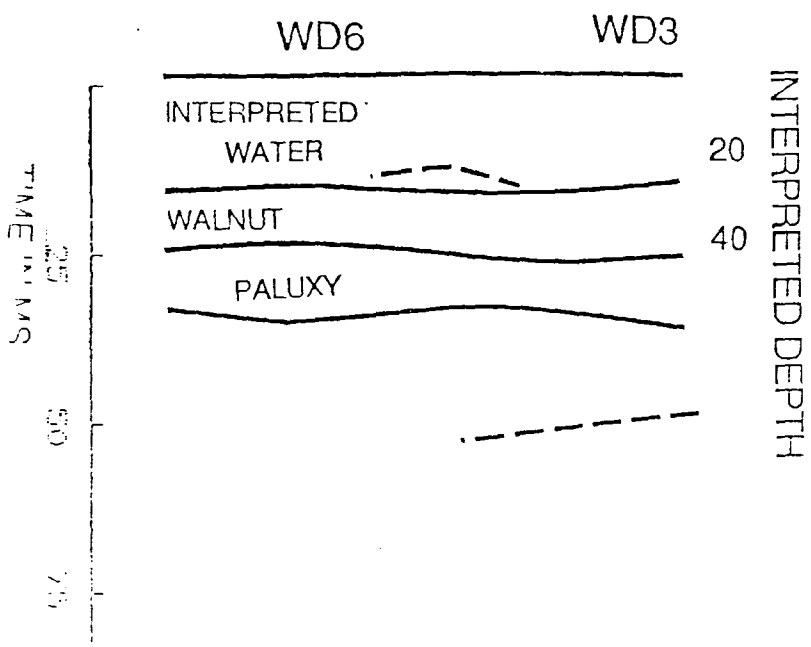
SEISMIC REFLECTION PROFILE



SEISMIC REFLECTION PROFILE



INTERPRETED SEISMIC REFLECTION PROFILE



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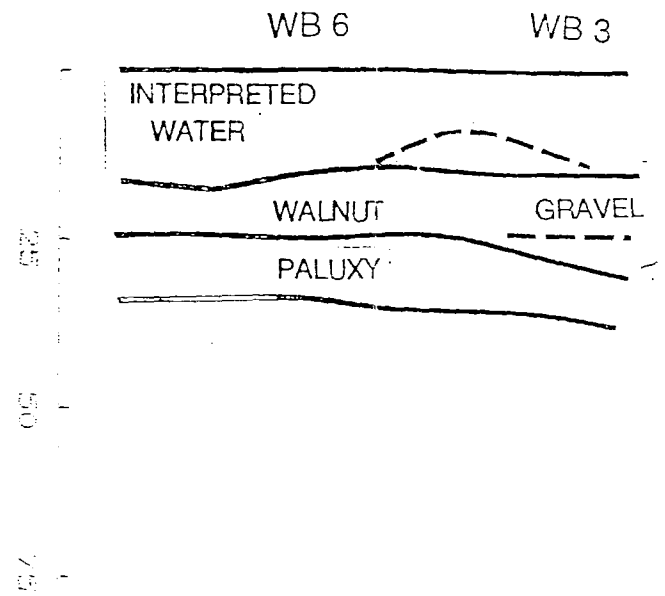
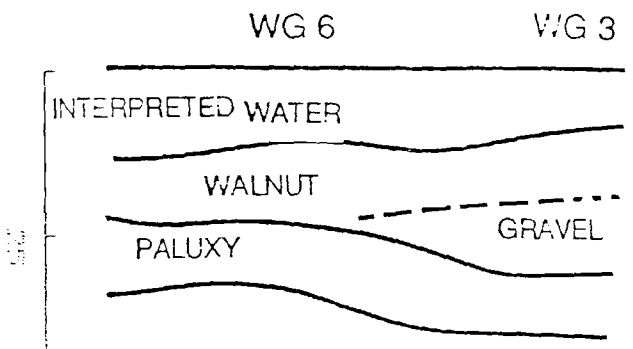


INTERPRETED SEISMIC REFLECTION PROFILE



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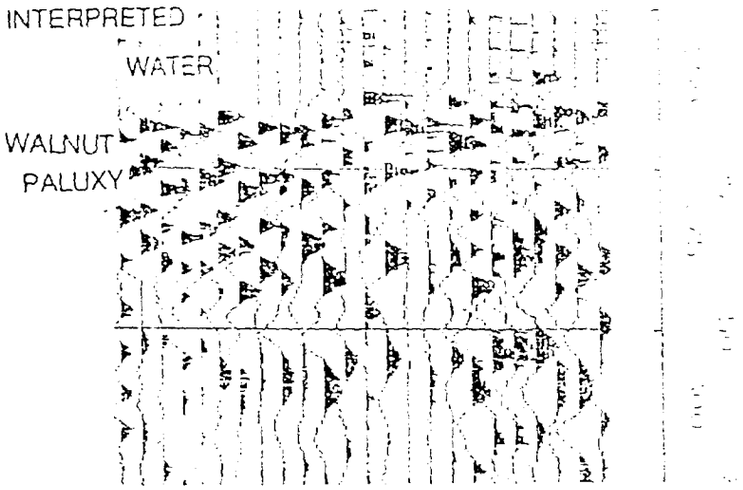
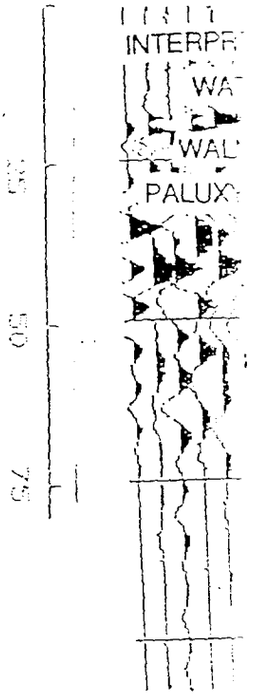
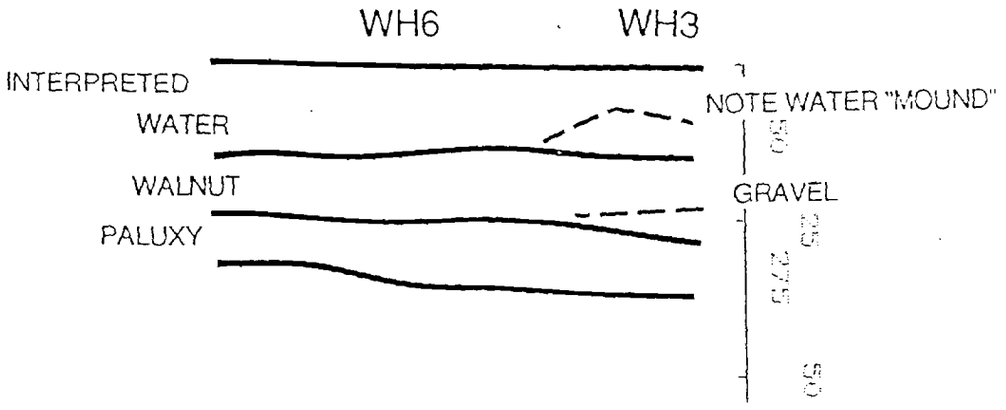
SEISMIC REFLECTION PROFILE



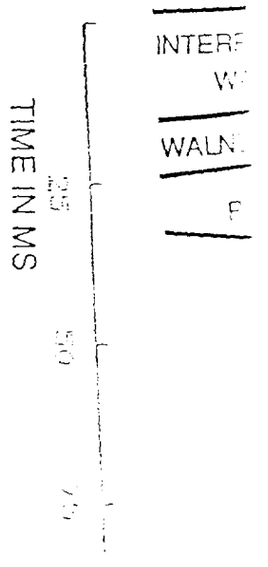
SEISMIC



INTERPRETED SEISMIC REFLECTION PROFILE



INTERPRE



GENERAL DYNAMICS PLANT
1941 TOPOGRAPHIC MAP
Note: Orient using plant entry

FIGURE 7

41172

ASSEMBLY BUILDING
FIN. FL. ELEV. 655.3'
ROAD
AREA
14'WALK
3-4'GATES
2-12'GATES
BOILER HOUSE
FL. ELEV. 655.3'
MAINTENANCE BUILDING
FL. ELEV. 655.3'
OFFICE BUILDING
FL. ELEV. 655.3'
EL. 653.9'
U.G. DUCT
2-12'GATES
2-6'GATES
CAFETERIA
FL. EL. 655.3'
6'WALK
GRASS
AREA
22 CONCRETE ROAD
6'WALK
GRASS
AREA
3-4'GATES
R. 14+69
S. 41+00
EL. 654.8'
S. 35+90
EL. 652.3'
2.18%
SLOPE 1.021%
CONCRETE
APRON
UNDERGROUND DUCT
SLOPE 1.021%
SLOPE 0.96%
FLAGPOLE
EL. 650.0'
R. 11+00
EL. 650.0'
EL. 651.5'
R. 10+00
EL. 651.5'
EL. 650.0'
R. 11+00
EL. 650.0'
EL. 651.5'
R. 10+00
EL. 651.5'
3-4'GATES
EL. 652.4'
HANGAR BUILDING
FIN. FL. ELEV. 652.9'
EL. 652
S. 45+35
150'
3-A.C. GASOLINE UNITS
A.C. GAS. LINE
R. 5+02
SLOPE 2.1%
FLUSH PIT
R. 4+76.55
S. 42+07.7
ELEV. 647.0'
GUARD HOUSE TYPE-2W
R. 3+67
S. 46+60
ELEV. 645.8'
R. 2+75
S. 45+40
ELEV. 645.8'
EMPLOYEE'S PARKING AREA
ASPHALTIC CONCRETE SURFACE
S. 20+55
S. 25+87.5
S. 28+20
S. 31+52.5
S. 36+
S. 40+82
210'
EMPLOYMENT BUILDING
EL. 648.12
GUARD BUILDING
EL. 648.12
48'ELECTRICALLY OPERATED GATE
2-12'GATES
2-12'GATES
2-12'GATES
2-12'GATES
2-12'GATES
U.S. GOVERNMENT PROPERTY LINE
LANE
PARKING AREA
CONCRETE SURFACE
STATION 20+00
STATION 25+00
STATION 30+00
STATION 35+00
STATION 40+00

REVISION | BY | CHK BY | AUSTIN CO APPROVED | DATE | U.S. ENGINEER APPROVED | DATE

Appendix D

APPENDIX D

ON-SITE ANALYSIS OF WATER FROM BOREHOLES DRILLED ON CARSWELL AIR FORCE BASE, FORT WORTH, TEXAS

41174 255

MICROSEEPS LTD

University of Pittsburgh Applied Research Center
220 William Pitt Way, Pittsburgh, PA 15238
(412) 826-5245

December 21. 1988

Mr. Sam Williams
Hargis & Associates. Inc.
Suite 300
2223 Avenida De La Playa
La Jolla, CA. 92037

Dear Mr. Sam Williams.

Attached is the final report for the on-site water analysis at Carswell Air Force Base. Also attached is the data listings (final and raw) and the invoice for the period of work.

Putting aside the long hours, it was a pleasure working with everyone involved in the project. Thank you for giving us the opportunity to demonstrate our capabilities. Please contact me if you have any questions or I can be of further assistance.

Best Regards.

Dave Masdea

FINAL REPORT

"ON-SITE ANALYSIS OF WATER FROM BORE HOLES DRILLED ON CARSWELL AIR FORCE BASE, FORT WORTH, TEXAS"

I. GENERAL

Automated headspace gas chromatography was performed at the General Dynamics Plant / Carswell Air Force Base by Microseeps Ltd. for groundwater analysis. The period of performance was Dec. 5, 1988 through Dec. 14, 1988. A lab trailer was mobilized on site and outfitted with all necessary equipment. Groundwater grab samples were collected from bore holes and transported to the lab trailer where they were prepared then analyzed for selected volatile organic compounds. Data were presented in updated listings during this period and in floppy disk format at the conclusion.

II. SAMPLE COLLECTION AND PREPARATION

An initial 'timed sampling' experiment, directed by Sam Williams determined that VOC concentration levels in the bore hole increased with time and bail out after drilling. Therefore a minimum 1 hour waiting period was used before bailing out the bore hole and sampling. The samples were then poured from the bailer into 40 ml glass vials equipped with teflon lined screw caps. Generally four samples were collected at each site and labeled with suffix A through D.

Samples were prepared immediately after being received and logged in at the trailer. Twelve ml of sample was transferred from the 40 ml vial by glass pipette into a 22 ml headspace vial. Next the vial was capped with a teflon lined crimp on cap then placed in a 75 deg.C heated bath for a minimum of 90 minutes prior to injection into the G.C. Sediment in the 40 ml sample vials varied from very little to about 75 %. In most cases two headspace vials could be made up from sample 'A' before sediment was encountered. During the start up period, in an attempt to minimize possible background contamination, several sets of 22 ml headspace vials were filled in the field at sites HM-99 and TB-1. The headspace was then created in the vial by displacing 10 ml of sample with 10 cc of nitrogen. The results proved unacceptable mainly due to varying amounts of sediment in the vials from sample to sample. These results are included in the raw data listing only.

During the last day of sampling, two sets of soil gas samples (four in all) were collected from 3 foot deep near two high concentration bore hole locations. Only one sample showed a barely detectable amount of trichloroethylene.

III. ANALYSIS

The analytical equipment utilized in the mobile lab trailer is as follows: Hewlett Packard 5890 Gas Chromatograph (equipped with a flame ionization and electron capture detector), H.P. 19395A Automated Headspace Sampling Unit, and a H.P. 3392A Integrator interfaced to an I.B.M. Personal Computer with Printer. The column used is a Supelco VOCOL wide bore capillary, 60 meters x 0.75mm ID, 1.5um film. This column is specially designed to provide high resolution of the volatile organic compounds. Because of prior known concentration range of samples the F.I.D. was selected.

Sample vials placed in the heated headspace unit were mechanically punctured to transfer the sample vapor to a sample loop and then onto the column. After compound separation and detection the resulting signal peaks were integrated. The area counts were then transmitted to the computer were concentration levels were calculated. Each injection to injection time is 44 minutes, this includes column burn off between samples. In all there were 163 gas chromatograph injections. They included 87 water samples (duplicates, triplicates & initial test), 42 standards, 26 background checks, and 6 miscellaneous.

IV. STANDARDS AND CALIBRATIONS

A high concentration base standard blend was made in methanol so that 10 ul of blend contains 120 mg of each compound. When 120 mg of compound(s) is injected into 12 ml of filtered water (blank) a 10 PPM standard is produced. Dilutes of 10:1 and 100:1 of the base blend were made in order to produce lower concentration standards in water. The water standards were made by injecting ul amounts of blend into a capped vial filled with 12 ml of filtered water.

Based on prior experience with the VOCOL column it was determined that cis-1,2 dichloroethylene was an unknown major component in the samples. A new base standard was then made to include this compound and the concentration levels were back calculated. Sensitivity levels remained relatively stable though out the period of performance.

Calibration points were at 10ppb, 100ppb, 1ppm and 10ppm. Even though this method demonstrated good linearity, sample concentration levels were calculated from standard calibration points closest to the sample concentration. Standards analyzed during the course of analyzing samples were averaged into the calibration table as well as being used for peak identification.

V. QUALITY ASSURANCE AND QUALITY CONTROL

Blanks and standards were analyzed daily along with the samples. Fresh charcoal filtered distilled water was used for the blanks. All glassware was washed, rinsed and then baked at 100

deg. C prior to use. The procedure used to make up the blanks duplicated sample preparation and reflected any background that might exist in the instruments or lab trailer. An initial air sample taken in the field showed no background. The only background measured was trans 1,2 dichloroethylene with the highest level reaching 6 ppb. This background existed during the first three days of work and was subtracted from the concentration results of samples made up during that time.

The Headspace sampling unit contains the heated bath as well as a heated sampling loop and transfer line. The latter two zones are continually flushed with nitrogen in between sample analysis to minimize chance of carry over. This nitrogen in the sample loop was injected periodically to check for instrument contamination.

Care was taken to insure as little disturbance as possible to the sample upon transfer to the headspace vials. A new sterile pipette was used for each sample. At least two vials were initially prepared for each sample. Occasionally a third vial, and fourth if necessary, was prepared and analyzed if comparison of results varied more than 10 percent. The 40ml field vials were discarded after samples were transferred from them. If later another sample was required it was taken from field vial "B" or "C". These 'backup' field vials were kept refrigerated at approximately 4 deg. C. until needed. Near the completion, samples HM-99 and HM-95 were re-analyzed after being refrigerated 9 days. The results demonstrate excellent reproducabilty and are shown in the final listing.

Base standard blends in methanol, made from pure compounds. were not used when over one week old. Standards in water were prepared daily immediately before being placed in the headspace unit for analysis. All headspace vials were analyzed one time only.

Minimum detection levels, based on a signal to noise ratio of at least 4:1, are approximately 1 ppb for each compound. Because of its isolated occurrence, the initial trans 1,2 dichloroethylene background was not factor into its M.D.L. A zero on the final data listing means 'below the minimum detection level'. Higher sample concentration were not rounded off and may reflect a higher degree of accuracy than actually achieved.

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---- HARGIS & ASSOCIATES, INC. ----
---- CARSWELL AIRFORCE BASE, FORT WORTH, TX. ----
---- WATER CONCENTRATION BY WEIGHT IN PPB ----

SAMPLE NUMBER	RUN #	DATE CLTD	TIME CLTD	T1,2-DiCl ETHYLENE	C1,2-DiCl ETHYLENE	TriCl ETHYLENE	TetraCl ETHYLENE	TCE/ CIS	SAMPLE NUMBER
HM 99	25	12/5/88	1100	0	84	425	0	5.1	HM 99
HM 99	27	12/5/88	1100	0	87	471	0	5.4	HM 99
TB1 AIR	24	12/5/88	1130	0	0	0	0	-	TB1 AIR
TB1-A	33	12/5/88	1115	0	19	176	0	9.3	TB1-A
TB1-B	34	12/5/88	1130	0	18	172	0	9.6	TB1-B
TB1-C	35	12/5/88	1150	0	19	206	0	10.9	TB1-C
TB1-D	36	12/5/88	1215	0	25	289	0	11.6	TB1-D
TB1-A	46	12/5/88	1115	0	18	177	0	9.9	TB1-A
TB1-B	47	12/5/88	1130	0	18	189	3	10.5	TB1-B
TB1-C	48	12/5/88	1150	0	20	215	3	10.8	TB1-C
TB1-D	49	12/5/88	1215	0	23	268	0	11.7	TB1-D
HM-95A	52	12/6/88	1720	0	222	5340	0	24.1	HM-95A
HM-95A	53	12/6/88	1720	0	216	5253	0	24.3	HM-95A
HM-95B	54	12/6/88	1720	0	222	5458	0	24.6	HM-95B
HM-95B	55	12/6/88	1720	0	221	5452	0	24.7	HM-95B
RSB-34A	61	12/7/88	1310	6	294	2458	0	8.4	RSB-34A
RSB-34A	62	12/7/88	1310	7	315	2792	0	8.9	RSB-34A
RSB-35A	63	12/7/88	1345	1	0	0	0	-	RSB-35A
RSB-35A	64	12/7/88	1345	2	0	0	0	-	RSB-35A
RSB-36A	67	12/7/88	1710	0	0	3	0	-	RSB-36A
RSB-36B	68	12/7/88	1710	0	0	6	0	-	RSB-36B
RSB-38A	69	12/7/88	1825	12	106	363	0	3.4	RSB-38A
RSB-38A	70	12/7/88	1825	12	107	375	0	3.5	RSB-38A
RSB-39A	73	12/8/88	1155	4	228	2183	0	9.6	RSB-39A
RSB-39B	74	12/8/88	1155	4	239	2485	0	10.4	RSB-39B
RSB-40A	75	12/8/88	1240	530	401	181	0	0.5	RSB-40A
RSB-40A	76	12/8/88	1240	561	409	194	0	0.5	RSB-40A
RSB-41A	80	12/8/88	1755	20	636	2481	0	3.9	RSB-41A
RSB-41A	81	12/8/88	1755	21	638	2650	0	4.2	RSB-41A
RSB-42A	82	12/8/88	1800	0	0	0	0	-	RSB-42A
RSB-42A	83	12/8/88	1800	0	0	0	0	-	RSB-42A
RSB-43A	90	12/9/88	1250	2	53	318	0	6.0	RSB-43A
RSB-43B	100	12/9/88	1250	0	55	392	0	7.1	RSB-43B
RSB-44A	91	12/9/88	1335	0	11	280	0	25.9	RSB-44A
RSB-44A	92	12/9/88	1335	0	11	308	0	27.5	RSB-44A
RSB-45A	95	12/9/88	1710	0	8	558	0	73.6	RSB-45A
RSB-45A	96	12/9/88	1710	1	8	625	2	78.3	RSB-45A
RSB-46A	97	12/9/88	1730	0	10	820	5	78.1	RSB-46A
RSB-46A	98	12/9/88	1730	0	11	837	6	78.1	RSB-46A
RSB-47A	107	12/10/88	1100	0	0	41	0	-	RSB-47A
RSB-47B	121	12/10/88	1100	0	0	44	0	-	RSB-47B
RSB-50A	106	12/10/88	1200	0	0	0	0	-	RSB-50A
RSB-50A	108	12/10/88	1200	0	0	0	0	-	RSB-50A
RSB-50E	112	12/11/88	905	0	0	0	0	-	RSB-50E
RSB-51A	115	12/11/88	1040	2	72	525	0	7.3	RSB-51A
RSB-51A	116	12/11/88	1040	2	70	522	0	7.4	RSB-51A
RSB-52A	117	12/11/88	1115	0	0	0	0	-	RSB-52A
RSB-52A	118	12/11/88	1115	0	0	0	0	-	RSB-52A

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---- HARGIS & ASSOCIATES, INC. ----
---- CARSWELL AIRFORCE BASE, FORT WORTH, TX. ----
---- WATER CONCENTRATION BY WEIGHT IN PPB ----

SAMPLE NUMBER	RUN #	DATE CLTD	TIME CLTD	T1,2-DiCl ETHYLENE	C1,2-DiCl ETHYLENE	TriCl ETHYLENE	TetraCl ETHYLENE	TCE/ CIS	SAMPLE NUMBER
RSB-53A	119	12/11/88	1140	1	0	2	0	-	RSB-53A
RSB-53B	120	12/11/88	1140	0	0	2	0	-	RSB-53B
RSB-54A	124	12/11/88	1545	0	7	239	0	34.2	RSB-54A
RSB-54A	125	12/11/88	1545	0	7	240	0	34.2	RSB-54A
RSB-55A	126	12/11/88	1650	0	3	152	0	46.8	RSB-55A
RSB-55A	127	12/11/88	1650	0	3	156	0	47.9	RSB-55A
RSB-56A	128	12/11/88	1725	0	12	774	3	66.1	RSB-56A
RSB-56A	129	12/11/88	1725	0	12	786	3	66.2	RSB-56A
RSB-58A	130	12/12/88	1350	0	0	0	0	-	RSB-58A
RSB-58A	131	12/12/88	1350	0	0	0	0	-	RSB-58A
RSB-59A	137	12/12/88	1515	13	665	2360	0	3.5	RSB-59A
RSB-59A	138	12/12/88	1515	15	710	2760	0	3.9	RSB-59A
RSB-59B	144	12/12/88	1515	14	629	2540	0	4.0	RSB-59B
RSB-60A	139	12/12/88	1610	0	0	0	0	-	RSB-60A
RSB-60A	140	12/12/88	1610	0	0	0	0	-	RSB-60A
RSB-61A	141	12/12/88	1815	0	2	103	0	51.5	RSB-61A
RSB-61A	142	12/12/88	1815	0	2	101	0	50.5	RSB-61A
RSB-61E	147	12/13/88	845	0	2	84	0	35.0	RSB-61E
RSB-61E	148	12/13/88	845	0	2	83	0	40.8	RSB-61E
RSB-62A	149	12/13/88	900	2	2	89	0	51.1	RSB-62A
RSB-62A	150	12/13/88	900	2	2	92	0	55.3	RSB-62A
RSB-63A	151	12/13/88	1130	0	16	874	4	56.2	RSB-63A
RSB-63A	152	12/13/88	1130	0	13	902	4	68.3	RSB-63A
RSB-64A	153	12/13/88	1230	0	6	544	3	84.7	RSB-64A
RSB-64A	154	12/13/88	1230	0	7	552	3	84.2	RSB-64A
RSB-66A	155	12/13/88	1810	14	707	2359	0	3.3	RSB-66A
RSB-66A	156	12/13/88	1810	15	727	2635	0	3.6	RSB-66A
HM-99	163	12/5/88	1100	1	97	496	0	5.1	HM-99
HM-99	164	12/5/88	1100	2	93	477	0	5.1	HM-99
HM-95C	165	12/6/88	1720	1	224	5236	0	23.3	HM-95C
HM-95C	166	12/6/88	1720	1	230	5422	0	23.5	HM-95C

SAMPLE	RUN#	TRANS R.T.	TRANS AREA	PPB OR AVG AREA	AMT/ AREA	BKG. AREA
LAB AIR	1	-	-			
BLANK	2	-	-			
10 PPB	3	4.00	7259			
10 PPB	4	3.96	8973	9042	0.001106	
10 PPB	5	3.93	9227			
10 PPB	42	4.08	7680			
10 PPB	43	4.08	11795			
10 PPB	101	4.13	9319	-		
100 PPB	6	3.85	85059			
100 PPB	7	3.80	79121			
100 PPB	8	3.87	82145	85112	0.001175	
100 PPB	39	4.05	80211			
100 PPB	44	4.08	79910			
100 PPB	45	4.04	91264			
100 PPB	50	4.05	89970			
100 PPB	71	4.05	82496	-		
100 PPB	102	4.13	90103	-		
100 PPB	103	4.12	90225	-		
100 PPB	111	4.11	90559	-		
100 PPB	113	4.09	79188	-		
100 PPB	132	4.12	87625			
100 PPB	145	3.88	83690	-		
BLANK	9	-	-			
1 PPM	10	4.03	785540			
1 PPM	11	4.07	948050	881549	0.001134	
1 PPM	12	4.09	933460			
1 PPM	41	3.97	688550			
1 PPM	56	4.07	951910			
1 PPM	57	4.08	942690			
1 PPM	78	4.15	943810	-		
1 PPM	104	4.11	858380	-		
10 PPM	13	4.11	8936200			
10 PPM	14	4.12	8655900	9102500	0.001099	
10 PPM	15	4.14	9031400			
10 PPM	84	4.18	9221900	-		
10 PPM	85	4.18	9667100	-		
BLANK	16	4.16	6582			6582
TB1 AIR	24	-	-	-		
HM 99 40ML	25	4.03	3313	0	0.001178	6582
HM 99 22ML	26	4.05	14406	9	0.001178	6582
HM 99 40ML	27	4.07	3241	0	0.001178	6582
HM 99 22ML	28	4.09	8878	3	0.001178	6582
TB1-D 22ML	29	4.04	5934	0	0.001178	6582
TB1-C 22ML	30	4.02	5935	0	0.001178	6582

SAMPLE	RUN#	TRANS R.T.	TRANS AREA	PPB OR AVG AREA	AMT/ AREA	BKG. AREA
TB1-B 22ML	31	4.04	6496	0	0.001178	6582
TB1-A 22ML	32	4.06	7784	1	0.001178	6582
TB1-A 40ML	33	4.07	2767	0	0.001178	6582
TB1-B 40ML	34	4.09	3315	0	0.001178	6582
TB1-C 40ML	35	4.10	5254	0	0.001178	6582
TB1-D 40ML	36	4.12	5310	0	0.001178	6582
100 PPB	39	4.05	80211	119	0.001489	
BLANK	40	-	-	-		
1 PPM	41	3.97	688550	787	0.001143	
10 PPB	42	4.08	7680	9	0.001113	
10 PPB	43	4.08	11795	13	0.001113	
100 PPB	44	4.08	79910	95	0.001191	
100 PPB	45	4.04	91264	109	0.001191	
TB1-A 40ML	46	4.01	2609	0	0.001113	5254
TB1-B 40ML	47	3.99	3438	0	0.001113	5254
TB1-C 40ML	48	4.00	4966	0	0.001113	5254
TB1-D 40ML	49	4.02	4371	0	0.001113	5254
100 PPB	50	4.05	89970	101	0.001191	5254
BLANK	51	4.10	5254	0	0.001113	5254
HM-95A	52	4.06	1493	0	0.001113	5254
HM-95A	53	4.07	1600	0	0.001113	5254
HM-95B	54	4.07	1777	0	0.001113	5254
HM-95B	55	4.07	1689	0	0.001113	5254
1 PPM	56	4.07	951910	1082	0.001143	5254
1 PPM	57	4.08	942690	1071	0.001143	5254
BLANK	58	4.09	1040	0	0.001113	1040
TCM I.D.	59	-	-	0		1040
TCM I.D.	60	-	-	0		1040
RSB-34A	61	4.01	6388	6	0.001113	1040
RSB-34A	62	4.06	7162	7	0.001113	1040
RSB-35A	63	4.08	2076	1	0.001113	1040
RSB-35A	64	4.09	2538	2	0.001113	1040
BLANK	65	-	-	-		
TRAILER AIR	66	-	-	-		
RSB-36A	67	-	-	-		
RSB-36B	68	-	-	-		
RSB-38	69	4.11	10726	12	0.001113	
RSB-38	70	4.11	11186	12	0.001113	
100 PPB	71	4.05	82496	98	0.001194	
BLANK	72	-	-	-		
RSB-39A	73	4.06	3383	4	0.001113	
RSB-39B	74	4.04	3684	4	0.001113	
RSB-40A	75	4.02	468920	530	0.001130	
RSB-40A	76	4.01	496280	561	0.001130	
N2 IN LOOP	77	-	-	-		
1 PPM	78	4.15	943810	1067	0.001130	
BLANK	79	-	-	-		
RSB-41A	80	4.18	17769	20	0.001113	
RSB-41A	81	4.18	18560	21	0.001113	
RSB-42A	82	-	-	-		
RSB-42A	83	-	-	-		
10 PPM	84	4.18	9221900	10131	0.001099	

SAMPLE	RUN#	TRANS R.T.	TRANS AREA	PPB OR AVG AREA	AMT/ AREA	BKG. AREA
10 PPM	85	4.18	9667100	10620	0.001099	
GD SINK H2O	86	-	-	-		
BLANK	87	-	-	-		
N2 IN LOOP	88	-	-	-		
RSB-43A	89	3.97	869	1	0.001106	
RSB-43A	90	4.03	2017	2	0.001106	
RSB-44A	91	-	-	-		
RSB-44A	92	-	-	-		
N2 IN LOOP	93	-	-	-		
N2 IN LOOP	94	-	-	-		
RSB-45A	95	-	-	-		
RSB-45A	96	4.12	753	1	0.001106	
RSB-46A	97	-	-	-		
RSB-46A	98	-	-	-		
BLANK	99	-	-	-		
RSB-43B	100	-	-	-		
10 PPB	101	4.13	9319	10	0.001106	
100 PPB	102	4.13	90103	106	0.001176	
100 PPB	103	4.12	90225	106	0.001176	
1 PPM	104	4.11	858380	974	0.001134	
RSB-47A	105	-	-	-		
RSB-50A	106	-	-	-		
RSB-47A	107	-	-	-		
RSB-50A	108	-	-	-		
BLANK	109	-	-	-		
10 PPB	110	4.10	7897	9	0.001106	
100 PPB	111	4.11	90659	107	0.001176	
RSB-50E	112	-	-	-		
100 PPB	113	4.09	79188	93	0.001176	
BLANK	114	-	-	-		
RSB-51A	115	4.09	1430	2	0.001106	
RSB-51A	116	4.05	1385	2	0.001106	
RSB-52A	117	-	-	-		
RSB-52A	118	-	-	-		
RSB-53A	119	4.09	1350	1	0.001106	
RSB-53B	120	-	-	-		
RSB-47B	121	-	-	-		
100 PPB	122	4.02	*** NOT	-		
BLANK	123	-	-	-		
RSB-54A	124	-	-	-		
RSB-54A	125	-	-	-		
RSB-55A	126	-	-	-		
RSB-55A	127	-	-	-		
RSB-56A	128	-	-	-		
RSB-56A	129	-	-	-		
RSB-58A	130	-	-	-		
RSB-58A	131	-	-	-		
100 PPB	132	4.12	87625	103	0.001176	
BLANK	133	-	-	-		
N2 IN LOOP	134	-	-	-		
N2 IN LOOP	135	-	-	-		
N2 IN LOOP	136	-	-	-		

SAMPLE	RUN#	TRANS R.T.	TRANS AREA	PPB OR AVG AREA	AMT/ AREA	BKG. AREA
RSB-59A	137	4.12	11698	13	0.001106	
RSB-59A	138	4.13	13898	15	0.001106	
RSB-60A	139	-	-	-		
RSB-60A	140	-	-	-		
RSB-61A	141	-	-	-		
RSB-61A	142	-	-	-		
N2 IN LOOP	143	-	-	-		
RSB-59B	144	3.95	12216	14	0.001106	
100 PPB	145	3.88	83690	98	0.001175	
BLANK	146	-	-	-		
RSB-61E	147	-	-	-		
RSB-61E	148	-	-	-		
RSB-62A	149	4.04	1442	2	0.001106	
RSB-62A	150	4.05	1448	2	0.001106	
RSB-63A	151	-	-	-		
RSB-63A	152	-	-	-		
RSB-64A	153	-	-	-		
RSB-64A	154	-	-	-		
RSB-66A	155	4.10	12373	14	0.001106	
RSB-66A	156	4.11	13475	15	0.001106	
SG 41S-A	157	-	-	-		
SG 41S-B	158	4.14	1215	-		
SG 41N	159	-	-	-		
SG 34S	160	-	-	-		
SG 34N	161	-	-	-		
1.2ng GAS STD	162	-	-	-		
HM-99	163	4.17	1312	1	0.001106	
HM-99	164	4.15	1780	2	0.001106	
HM-95C	165	4.14	1214	1	0.001106	
HM-95C	166	4.18	1115	1	0.001106	
N2 IN LOOP	167	-	-			

SAMPLE	RUN#	CIS R.T.	CIS AREA	PPB OR AVG AREA	AMT/ AREA
LAB AIR	1				
BLANK	2				
10 PPB	3				
10 PPB	4				
10 PFB	5				
10 PPB	42	-	-		
10 PPB	43	-	-		
10 PPB	101	5.45	6740	6740	0.001484
100 PPB	6				
100 PPB	7				
100 PPB	8				
100 PPB	39				
100 PPB	44				
100 PPB	45				
100 PPB	50				
100 PPB	71	-	-	-	
100 PPB	102	5.45	62143	61198	0.001634
100 PPB	103	5.44	61965	-	
100 PPB	111	5.43	62291	-	
100 PPB	113	5.41	59944		
100 PPB	132	5.44	63274		
100 PPB	145	5.14	57569	-	
BLANK	9				
1 PPM	10				
1 PPM	11				
1 PPM	12				
1 PPM	41				
1 PPM	56				
1 PPM	57				
1 PPM	78				
1 PPM	104	5.43	595230	595230	0.001680
10 PPM	13				
10 PPM	14				
10 PPM	15				
10 PPM	84	-	-	-	
10 PPM	85	-	-	-	
BLANK	16	-	-	-	
TB1 AIR	24	-	-	-	
HM 99 40ML	25	5.33	51852	84	0.001611
HM 99 22ML	26	5.35	49428	80	0.001611
HM 99 40ML	27	5.38	53744	87	0.001611
HM 99 22ML	28	5.40	46251	75	0.001611
TB1-D 22ML	29	5.34	12774	19	0.001484
TB1-C 22ML	30	5.33	8868	13	0.001484

SAMPLE	RUN#	CIS R.T.	CIS AREA	PPB OR AVG AREA	AMT/ AREA
TB1-B 22ML	31	5.35	9076	13	0.001484
TB1-A 22ML	32	5.37	10368	15	0.001484
TB1-A 40ML	33	5.39	12512	19	0.001484
TB1-B 40ML	34	5.42	11837	18	0.001484
TB1-C 40ML	35	5.44	13126	19	0.001484
TB1-D 40ML	36	5.45	16788	25	0.001484
100 PPB	39	-	-	-	
BLANK	40	-	-	-	
1 PPM	41	-	-	-	
10 PPB	42	-	-	-	
10 PPB	43	-	-	-	
100 PPB	44	-	-	-	
100 PPB	45	-	-	-	
TB1-A 40ML	46	5.32	12411	18	0.001484
TB1-B 40ML	47	5.30	12240	18	0.001484
TB1-C 40ML	48	5.31	13214	20	0.001484
TB1-D 40ML	49	5.33	15811	23	0.001484
100 PPB	50	-	-		
BLANK	51	-	-		
HM-95A	52	5.37	137610	222	0.001611
HM-95A	53	5.38	134200	216	0.001611
HM-95B	54	5.38	138020	222	0.001611
HM-95B	55	5.38	137020	221	0.001611
1 PPM	56				
1 PPM	57				
BLANK	58	-	-		
TCM I.D.	59	-	-		
TCM I.D.	60	-	-		
RSB-34A	61	5.30	182380	294	0.001611
RSB-34A	62	5.37	195190	315	0.001611
RSB-35A	63	-	-		
RSB-35A	64	-	-		
BLANK	65	-	-		
TRAILER AIR	66	-	-		
RSB-36A	67	-	-		
RSB-36B	68	-	-		
RSB-38	69	5.43	65621	106	0.001611
RSB-38	70	5.44	66485	107	0.001611
100 PPB	71	-	-	-	
BLANK	72	-	-	-	
RSB-39A	73	5.38	141390	228	0.001611
RSB-39B	74	5.34	148520	239	0.001611
RSB-40A	75	5.31	248880	401	0.001611
RSB-40A	76	5.29	253840	409	0.001611
N2 IN LOOP	77	-	-	-	
1 PPM	78	-	-	-	
BLANK	79	-	-	-	
RSB-41A	80	5.51	378600	636	0.001680
RSB-41A	81	5.52	379890	638	0.001680
RSB-42A	82	-	-	-	
RSB-42A	83	-	-	-	
10 PPM	84	-	-	-	

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SAMPLE	RUN#	CIS R.T.	CIS AREA	PPB OR AVG AREA	AMT/ AREA
10 PPM	85	-	-	-	
60 SINK H20	86	-	-	-	
BLANK	87	-	-	-	
N2 IN LOOP	88	-	-	-	
RSB-43A	89	5.26	27223	44	0.001611
RSB-43A	90	5.34	32772	53	0.001611
RSB-44A	91	5.41	7285	11	0.001484
RSB-44A	92	5.46	7541	11	0.001484
N2 IN LOOP	93	-	-	-	
N2 IN LOOP	94	-	-	-	
RSB-45A	95	5.49	5113	8	0.001484
RSB-45A	96	5.48	5376	8	0.001484
RSB-46A	97	5.47	7072	10	0.001484
RSB-46A	98	5.46	7221	11	0.001484
BLANK	99	-	-	-	
RSB-43B	100	5.45	34312	55	0.001611
10 PPB	101	5.45	6740	10	0.001484
100 PPB	102	5.45	62143	100	0.001611
100 PPB	103	5.44	61965	100	0.001611
1 PPM	104	5.43	595230	1000	0.001680
RSB-47A	105	-	-	-	
RSB-50A	106	-	-	-	
RSB-47A	107	-	-	-	
RSB-50A	108	-	-	-	
BLANK	109	-	-	-	
10 PPB	110	5.42	6987	10	0.001484
100 PPB	111	5.43	62291	101	0.001624
RSB-50E	112	-	-	-	
100 PPB	113	5.41	59944	97	0.001624
BLANK	114	-	-	-	
RSB-51A	115	5.42	44315	72	0.001624
RSB-51A	116	5.35	43286	70	0.001624
RSB-52A	117	-	-	-	
RSB-52A	118	-	-	-	
RSB-53A	119	-	-	-	
RSB-53B	120	-	-	-	
RSB-47B	121	-	-	-	
100 PPB	122	5.31	*** NOT USED ***		
BLANK	123	-	-		
RSB-54A	124	5.19	4710	7	0.001484
RSB-54A	125	5.26	4718	7	0.001484
RSB-55A	126	5.23	2191	3	0.001484
RSB-55A	127	5.23	2198	3	0.001484
RSB-56A	128	5.21	7895	12	0.001484
RSB-56A	129	5.30	8003	12	0.001484
RSB-58A	130	-	-	-	
RSB-58A	131	-	-	-	
100 PPB	132	5.44	63274	103	0.001624
BLANK	133	-	-	-	
N2 IN LOOP	134	-	-	-	
N2 IN LOOP	135	-	-	-	
N2 IN LOOP	136	-	-	-	

SAMPLE	RUN#	CIS R.T.	CIS AREA	PPB OR AVG AREA	AMT/ AREA
RSB-59A	137	5.44	395970	665	0.001680
RSB-59A	138	5.45	422520	710	0.001680
RSB-60A	139	-	-	-	
RSB-60A	140	-	-	-	
RSB-61A	141	5.46	1619	2	0.001484
RSB-61A	142	5.46	1587	2	0.001484
N2 IN LOOP	143	-	-	-	
RSB-59B	144	5.22	374690	629	0.001680
100 PPB	145	5.14	57569	94	0.001634
BLANK	146	-	-	-	
RSB-61E	147	5.30	1611	2	0.001484
RSB-61E	148	5.35	1377	2	0.001484
RSB-62A	149	5.37	1170	2	0.001484
RSB-62A	150	5.38	1116	2	0.001484
RSB-63A	151	5.44	10490	16	0.001484
RSB-63A	152	5.47	8896	13	0.001484
RSB-64A	153	5.44	4327	6	0.001484
RSB-64A	154	5.41	4416	7	0.001484
RSB-66A	155	5.41	421110	707	0.001680
RSB-66A	156	5.43	432710	727	0.001680
SG 41S-A	157	-	-	-	
SG 41S-B	158	-	-	-	
SG 41N	159	-	-	-	
SG 34S	160	-	-	-	
SG 34N	161	-	-	-	
1.2mg GAS STD	162	5.53	70946	116	0.001634
HM-99	163	5.51	59220	97	0.001634
HM-99	164	5.49	57201	93	0.001634
HM-95C	165	5.48	137340	224	0.001634
HM-95C	166	5.53	140910	230	0.001634
N2 IN LOOP	167	-	-		

SAMPLE	RUN#	TRICLENE R.T.	TRICLENE AREA	PPB OR AVG AREA	AMT/ AREA	PERCLENE R.T.	PERCLENE AREA	PPB OR AVG AREA	AMT/ AREA
LAB AIR	1	-	-			-	-		
BLANK	2	-	-			-	-		
10 PPB	3	8.67	7463			15.84	5530		
10 PPB	4	8.58	7932	9272	0.001078	15.75	7551	7589	0.001318
10 PPB	5	8.50	8833			15.67	7843		
10 PPB	42	8.85	11492			16.00	6608		
10 PPB	43	8.86	9409			16.01	7114		
10 PPB	101	8.96	10504	-		16.14	10889	-	
100 PPB	6	8.33	78074			15.48	73021		
100 PPB	7	8.25	71770	80594	0.001241	15.41	65914	71464	0.001399
100 PPB	8	8.41	75191			15.63	69228		
100 PPB	39	8.78	73418			15.93	66527		
100 PPB	44	8.85	78497			16.00	72744		
100 PPB	45	8.75	85000			15.89	80532		
100 PPB	50	8.79	81705			15.95	74555		
100 PPB	71	8.79	76341	-		15.93	70213	-	
100 PPB	102	8.95	87846	-		16.13	85867	-	
100 PPB	103	8.95	89364	-		16.12	91056	-	
100 PPB	111	8.92	88856	-		16.10	87181	-	
100 PPB	113	8.89	74450	-		-	-	-	
100 PPB	132	8.94	85249			16.11	81466	-	
100 PPB	145	8.48	82560	-		15.69	82197		
BLANK	9	-	-			-	-		
1 PPM	10	8.74	689910			15.92	594020		
1 PPM	11	8.83	868650	804429	0.001243	16.00	807100	736184	0.001358
1 PPM	12	8.87	840570			16.05	765170		
1 PPM	41	8.62	612520			15.80	532760		
1 PPM	56	8.84	894900			15.99	867310		
1 PPM	57	8.86	860710			16.01	784970		
1 PPM	78	9.00	848980	-		16.14	761140	-	
1 PPM	104	8.93	819190	-		16.11	777000	-	
10 PPM	13	8.94	8184300			16.12	7667500		
10 PPM	14	8.96	7908300	8349020	0.001198	16.14	7771900	7877660	0.001269
10 PPM	15	8.99	8337600			16.17	7924900		
10 PPM	84	9.10	8350800	-		16.24	7718400	-	
10 PPM	85	9.10	8964100	-		16.25	8705600	-	
BLANK	16	-	-			-	-		
TB1 AIR	24	-	-	-		-	-	-	
HM 99 40ML	25	8.75	319120	425	0.001333	-	-	-	
HM 99 22ML	26	8.78	293970	392	0.001333	15.95	4067	6	0.001434
HM 99 40ML	27	8.84	352940	471	0.001333	-	-	-	
HM 99 22ML	28	8.87	251850	336	0.001333	16.03	2581	4	0.001434
TB1-D 22ML	29	8.78	141600	189	0.001333	15.94	1665	2	0.001434
TB1-C 22ML	30	8.75	92656	124	0.001333	15.91	1651	2	0.001434

SAMPLE	RUN#	TRICLENE R.T.	TRICLENE AREA	PPB OR AVG AREA	AMT/ AREA	PERCLENE R.T.	PERCLENE AREA	PPB OR AVG AREA	AMT/ AREA
TB1-B 22ML	31	8.79	98073	131	0.001333	15.96	2263	3	0.001434
TB1-A 22ML	32	8.82	111760	149	0.001333	15.98	2174	3	0.001434
TB1-A 40ML	33	8.86	132140	176	0.001333	-	-	-	
TB1-B 40ML	34	8.90	129070	172	0.001333	-	-	-	
TB1-C 40ML	35	8.93	154710	206	0.001333	-	-	-	
TB1-D 40ML	36	8.96	217100	289	0.001333	-	-	-	
100 PPB	39	8.78	73418	98	0.001333	15.93	66527	93	0.001393
BLANK	40	-	-	-		-	-	-	
1 PPM	41	8.62	612520	771	0.001259	15.80	532760	735	0.001379
10 PPB	42	8.85	11492	13	0.001108	16.00	6608	10	0.001443
10 PPB	43	8.86	9409	10	0.001108	16.01	7114	10	0.001443
100 PPB	44	8.85	78497	101	0.001288	16.00	72744	101	0.001393
100 PPB	45	8.75	85000	109	0.001288	15.89	80532	112	0.001393
TB1-A 40ML	46	8.73	137790	177	0.001288	-	-		
TB1-B 40ML	47	8.71	146780	189	0.001288	15.96	2263	3	0.001443
TB1-C 40ML	48	8.73	167310	215	0.001288	15.98	2174	3	0.001443
TB1-D 40ML	49	8.76	208280	268	0.001288	-	-		
100 PPB	50	8.79	81705	105	0.001288	15.95	74555	104	0.001393
BLANK	51	-	-	-		-	-		
HM-95A	52	8.82	4242800	5210	0.001228	-	-		
HM-95A	53	8.84	4173800	5125	0.001228	-	-		
HM-95B	54	8.84	4336900	5326	0.001228	-	-		
HM-95B	55	8.84	4331700	5319	0.001228	-	-		
1 PPM	56	8.84	894900	1126	0.001259	15.99	867310	1196	0.001379
1 PPM	57	8.86	860710	1083	0.001259	16.01	784970	1082	0.001379
BLANK	58	-	-	-		-	-	-	
TCM I.D.	59	-	-	-		-	-	-	
TCM I.D.	60	-	-	-		-	-	-	
RSB-34A	61	8.71	1953200	2458	0.001259	-	-	-	
RSB-34A	62	8.82	2218100	2792	0.001259	-	-	-	
RSB-35A	63	-	-	-		-	-	-	
RSB-35A	64	-	-	-		-	-	-	
BLANK	65	-	-	-		-	-	-	
TRAILER AIR	66	-	-	-		-	-	-	
RSB-36A	67	8.87	2810	3	0.001108	-	-	-	
RSB-36B	68	8.90	5607	6	0.001108	-	-	-	
RSB-38	69	8.91	282170	363	0.001288	-	-	-	
RSB-38	70	8.93	290990	375	0.001288	-	-	-	
100 PPB	71	8.79	76341	99	0.001290	15.93	70213	98	0.001397
BLANK	72	-	-	-		-	-	-	
RSB-39A	73	8.83	1751200	2183	0.001246	-	-	-	
RSB-39B	74	8.77	1993700	2485	0.001246	-	-	-	
RSB-40A	75	8.72	140110	181	0.001290	-	-	-	
RSB-40A	76	8.70	150720	194	0.001290	-	-	-	
N2 IN LOOP	77	-	-	-		-	-	-	
1 PPM	78	9.00	848980	1058	0.001246	16.14	761140	1042	0.001369
BLANK	79	-	-	-		-	-	-	
RSB-41A	80	9.06	1990400	2481	0.001246	-	-	-	
RSB-41A	81	9.07	2126300	2650	0.001246	-	-	-	
RSB-42A	82	-	-	-		-	-	-	
RSB-42A	83	-	-	-		-	-	-	
10 PPM	84	9.10	8350800	10002	0.001198	16.24	7718400	9798	0.001269

SAMPLE	RUN#	TRICLENE R.T.	TRICLENE AREA	PPB OR AVG AREA	AMT/ AREA	PERCLENE R.T.	PERCLENE AREA	PPB OR AVG AREA	AMT/ AREA
10 PPM	85	9.10	8964100	10737	0.001198	16.25	8705600	11051	0.001269
GD SINK H20	86	-	-	-		-	-	-	
BLANK	87	-	-	-		-	-	-	
N2 IN LOOP	88	-	-	-		-	-	-	
RSB-43A	89	8.64	184430	231	0.001254	-	-	-	
RSB-43A	90	8.78	253760	318	0.001254	-	-	-	
RSB-44A	91	8.89	223090	280	0.001254	-	-	-	
RSB-44A	92	8.97	245660	308	0.001254	-	-	-	
N2 IN LOOP	93	-	-	-		-	-	-	
N2 IN LOOP	94	-	-	-		-	-	-	
RSB-45A	95	9.02	449130	558	0.001243	-	-	-	
RSB-45A	96	9.00	502710	625	0.001243	16.18	1315	2	0.001318
RSB-46A	97	8.98	659540	820	0.001243	16.17	4094	5	0.001318
RSB-46A	98	8.97	673300	837	0.001243	16.16	4476	6	0.001318
BLANK	99	-	-	-		-	-	-	
RSB-43B	100	8.96	312600	392	0.001254	-	-	-	
10 PPB	101	8.96	10504	11	0.001078	16.14	10889	14	0.001318
100 PPB	102	8.95	87846	110	0.001254	16.13	85867	115	0.001334
100 PPB	103	8.95	89364	112	0.001254	16.12	91056	121	0.001334
1 PPM	104	8.93	819190	1018	0.001243	16.11	777000	1055	0.001358
RSB-47A	105	8.85	22704	28	0.001249	-	-	-	
RSB-50A	106	-	-	-		-	-	-	
RSB-47A	107	8.85	32828	41	0.001249	-	-	-	
RSB-50A	108	-	-	-		-	-	-	
BLANK	109	-	-	-		-	-	-	
10 PPB	110	8.91	10237	11	0.001078	16.09	10762	14	0.001318
100 PPB	111	8.92	88856	111	0.001249	16.10	87181	125	0.001434
RSB-50E	112	-	-	-		-	-	-	
100 PPB	113	8.89	74450	93	0.001249	-	-	-	
BLANK	114	-	-	-		-	-	-	
RSB-51A	115	8.89	422610	525	0.001243	-	-	-	
RSB-51A	116	8.78	420230	522	0.001243	-	-	-	
RSB-52A	117	-	-	-		-	-	-	
RSB-52A	118	-	-	-		-	-	-	
RSB-53A	119	8.94	1428	2	0.001078	-	-	-	
RSB-53B	120	8.74	1715	2	0.001078	-	-	-	
RSB-47B	121	8.75	35492	44	0.001249	-	-	-	
100 PPB	122	*** NOT USED ***		-		*** NOT USED		-	
BLANK	123	-	-	-		-	-	-	
RSB-54A	124	8.51	192470	239	0.001243	-	-	-	
RSB-54A	125	8.63	192670	240	0.001243	-	-	-	
RSB-55A	126	8.57	122470	152	0.001243	-	-	-	
RSB-55A	127	8.58	125700	156	0.001243	-	-	-	
RSB-56A	128	8.56	622920	774	0.001243	15.77	2122	3	0.001318
RSB-56A	129	8.71	632630	786	0.001243	15.90	2175	3	0.001318
RSB-58A	130	-	-	-		-	-	-	
RSB-58A	131	-	-	-		-	-	-	
100 PPB	132	8.94	85249	107	0.001249	16.11	81466	-	
BLANK	133	-	-	-		-	-	-	
N2 IN LOOP	134	-	-	-		-	-	-	
N2 IN LOOP	135	-	-	-		-	-	-	
N2 IN LOOP	136	-	-	-		-	-	-	

SAMPLE	RUN#	TRICLENE R.T.	TRICLENE AREA	PPB OR AVG AREA	AMT/ AREA	PERCLENE R.T.	PERCLENE AREA	PPB OR AVG AREA	AMT/ AREA
RSB-59A	137	8.94	1898500	2360	0.001243	-	-	-	
RSB-59A	138	8.95	2219900	2760	0.001243	-	-	-	
RSB-60A	139	-	-	-		-	-	-	
RSB-60A	140	-	-	-		-	-	-	
RSB-61A	141	8.97	82547	103	0.001249	-	-	-	
RSB-61A	142	8.97	80932	101	0.001249	-	-	-	
N2 IN LOOP	143	-	-	-		-	-	-	
RSB-59B	144	8.57	2043600	2540	0.001243	-	-	-	
100 PPB	145	8.48	82560	102	0.001241	15.69	82197	115	0.001399
BLANK	146	-	-	-		-	-	-	
RSB-61E	147	8.71	67390	84	0.001241	-	-	-	
RSB-61E	148	8.78	67175	83	0.001241	-	-	-	
RSB-62A	149	8.82	71508	89	0.001241	-	-	-	
RSB-62A	150	8.85	73752	92	0.001241	-	-	-	
RSB-63A	151	8.93	703340	874	0.001243	16.12	2821	4	0.001318
RSB-63A	152	8.99	725600	902	0.001243	16.18	2899	4	0.001318
RSB-64A	153	8.94	437420	544	0.001243	16.11	2106	3	0.001318
RSB-64A	154	8.89	444020	552	0.001243	16.07	2113	3	0.001318
RSB-66A	155	8.90	1897300	2359	0.001243	-	-	-	
RSB-66A	156	8.92	2119800	2635	0.001243	-	-	-	
SG 41S-A	157	-	-			-	-	-	
SG 41S-B	158	-	-			-	-	-	
SG 41N	159	-	-			-	-	-	
SG 34S	160	9.05	1863			16.21	2641	-	
SG 34N	161	-	-			16.23	2172	-	
1.2mg GAS STD	162	9.08	73183	91	0.001241	16.23	57079	-	
HM-99	163	9.06	398810	496	0.001243	-	-	-	
HM-99	164	9.05	383380	477	0.001243	-	-	-	
HM-95C	165	9.04	4212200	5236	0.001243	-	-	-	
HM-95C	166	9.09	4361300	5422	0.001243	-	-	-	
N2 IN LOOP	167	-	-			-	-	-	
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Appendix E

APPENDIX E

LITHOLOGIC LOGS FOR

PALUXY MONITOR WELLS

APPENDIX E

TABLE OF CONTENTS

TABLE E-1

LITHOLOGIC LOG OF MONITOR WELL P-5UN

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 6.0	SILTY SAND - SANDY SILT	SM	Reddish brown (10 R 5/4), sand is fine- to very coarse-grained, sub-angular, silt is non-cohesive, non-plastic.
6.0 - 24.0	SAND SILT	SM	Grayish orange (10 YR 7/4), interbedded with pale orange (10 YR 8/2), silt is slightly cohesive, non-plastic, sand is approximately 30 percent, fine- to very fine-grained, well rounded.
24.0 - 32.0	SILTY GRAVELLY SAND	SP	Varicolored, fine- to medium-grained, slightly cohesive.
32.0 - 60.5	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 7), fossils, consist of oyster shell shards.
60.5 - 66.0	CLAY WITH LIMESTONE INTERBEDS	--	Limestone is same as above, clay is sandy, approximately 10 percent, fine- to medium-grained, subrounded, greenish gray (5 GY 4/1), slightly cohesive, slightly plastic.
66.0 - 68.0	SANDY CLAY - CLAYEY SAND	CL	Gray (N 3), very fine-grained, loose interbeds of sandy clay and clay, clay is gray (N 4), slightly cohesive, moderately plastic.
68.0 - 74.0	SANDY CLAY	SC	Gray (N 8), moderately cohesive, moderately plastic, sand decreases with depth.
74.0 - 76.5	SANDSTONE	--	Light gray, very well cemented, medium- to fine-grained, well rounded.
76.5 - 81.0	SANDY CLAY	SC	Gray (N 8), moderately cohesive, moderately plastic, some pyrite and lignite.

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-1 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-5UN

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
81.0 - 96.0	SAND	SP	Gray (N 7), fine- to medium-grained, subrounded, moderately cemented. At 81.0 to 84.0 feet, abundant pyrite and lignite.
96.0 - 98.0	SILTY CLAY	CL	Blue gray (5 B 7/1), slightly cohesive, slightly plastic.

TOTAL DEPTH OF BOREHOLE: 98 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by mud rotary

TABLE E-2

LITHOLOGIC LOG OF MONITOR WELL P-8UN

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 27.0	SILTY CLAY	CL	Grayish orange (10 YR 8/6), slightly plastic, slightly cohesive, firm, dry.
27.0 - 30.0	SANDY GRAVEL	GD	Varicolored, saturated, loose, medium- to very coarse-grained, well rounded.
30.0 - 58.5	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 8), dry, hard, abundant fossils, shale interbeds, Walnut Formation.
58.5 - 61.0	CLAYEY SANDSTONE	SP	Gray (N 4), wet, moderately cemented, sand is very fine-grained, well rounded.
61.0 - 73.0	SILTY CLAYSTONE	CL	Gray (N 5), wet, firm, slightly plastic non-cohesive.
73.0 - 84.0	SANDSTONE	SP	Whitish, moderately cemented, well sorted, very fine- to fine-grained, well rounded.
84.0 - 94.0	SILTY CLAY/SHALE	CL	Gray (N 4 to N 6), wet, firm, moderately plastic, moderately cohesive.

TOTAL DEPTH OF BOREHOLE: 94.0 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE E-3

LITHOLOGIC LOG OF MONITOR WELL P-9UN

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 0.5	ASPHALT AND SUBGRADE	--	
0.5 - 2.0	SILTY CLAY	CL	Brown (5 YR 3/4), moderately cohesive, slightly plastic.
2.0 - 7.0	SANDY SILT	SM	Grayish orange (10 YR 7/4), noncohesive nonplastic, sand is approixmately 30 percent, fine- to very coarse-grained, subangular to subrounded.
7.0 - 27.0	CLAYEY SILT - SILTY CLAY	ML - CL	Yellowish orange (10 YR 8/6), slightly cohesive, nonplastic, trace medium- to fine-grained sand.
27.0 - 36.0	SILTY SAND GRAVEL	GP	Varicolored, gravel is fine- to coarse-grained, subangular to rounded, sand is very fine- to coarse-grained, subangular to rounded.
36.0 - 63.0	FOSSILIFEROUS LIMESTONE WITH CLAY	--	Gray (N 7), hard, brittle, shell fragments are oyster shells, clay is interbedded, gray (N 2 to N 8), slightly cohesive, moderately plastic.
63.0 - 82.0	INTERBEDDED SILT, SAND, AND CLAY	SC	Gray (N 6 to N 8), sand is very fine-grained, clay is slightly cohesive. At 76.0 - 82.0 feet, drill cuttings indicate pyrite seams.
82.0 - 109	SANDSTONE	--	White to very light gray (N 8 to N 9), very fine- to medium-grained, well rounded, interbedded, loosely cemented to well cemented sandstone, trace silty sand.

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-3 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-9UN

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
109.0 - 112.0	SANDY CLAY	SC	Medium gray (N 5), cohesive, slightly plastic, sand is very fine-grained, some pyrite.

TOTAL DEPTH OF BOREHOLE: 112 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by mud rotary

TABLE E-4

LITHOLOGIC LOG OF MONITOR WELL P-11US

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0-1	ASPHALT AND SUBGRADE		Yellowish Brown (10 YR 5/4), with dark brown mottle, 50% clay, 50% silt, soft, plastic.
1-10	SILTY CLAY	CL	White to tan (2.5 Y 7/4), clay, very hard, dense, weathered, indurated reaction with HCl vigorous.
10-17	SHALE/LIMESTONE	--	Tan (2.5 Y 7/4), shale with black inclusions, reaction with HCl vigorous. Interbedded with tan limestone, soft to hard with depth.
17-54	SHALE/LIMESTONE	--	Gray (5 Y 6/1), shale, soft to hard, red staining. Interbedded with gray limestone, very hard brittle, more massive with depth. Lenses of white limestone with shell fragments with depth.
54-55	SILTY CLAY	CL	Gray (2.5 Y 6/1), 60 percent clay, 40 percent silt, plastic, soft to firm.
55-60	SAND WITH SILT	ML	Gray (2.5 Y 5/1), 90 percent sand, 10 percent silt, sand is very fine to fine, trace mica (biotite).
60-62	SILT/SAND SILT/CLAYEY SILT	ML-CL	Dark grayish brown (2.5 Y 4/2), to gray (5 Y 5/1), silt, dry, hard, graying to gray, 80 percent silt, 20 percent sand, sand is very fine, dry to slightly moist, slightly plastic, hard. At 62 feet, gray, 80 percent silt, 20 percent clay, plastic, hard.

TOTAL DEPTH OF BOREHOLE: 62 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-5

LITHOLOGIC LOG OF MONITOR WELL P-12UN

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0-1.5	CONCRETE AND FILL		
1.5-8.0	SILT	MH	Dark yellowish brown (10 YR 4/2), noncohesive buff colored chert nodules; trace sand.
8.0-15.0	SANDY SILTY LIMESTONE	--	Grayish orange (10 YR 7/4), silt is noncohesive, sand is fine grained 10-15 percent. At 10 feet, more varicolored sand, sub- to angular. At 14 feet, more silt, color change to light brown (5 YR 6/4). At 14.5 feet, gravel stringer, varicolored, fine-grained, subangular to subrounded.
15.0-58.0	FOSSILIFEROUS LIMESTONE	--	Medium light gray to medium gray (N 6 to N 5), dry well cemented, oyster fossils. At 20.5 to 21.0 feet, clay, medium light gray (N 6), sticky, cohesive, nonplastic. At 23.0 to 26.0 feet, same as above. At 37.0 to 38.0 feet, silty shale, shale is black; silt is medium gray (N 5). At 43.5 to 44.0 feet, soft layer, probably silt.
58.0-58.5	CLAYEY SILTSTONE	--	Medium gray (N 5), noncohesive.

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-5 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-12UN

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
58.5-61.0	LIMEY SANDSTONE	--	Medium gray (N 5), very fine-grained; some pyrite.
61.0-70.5	CLAYEY SILTSTONE-SANDY SILTSTONE	--	Medium gray (N 5), noncohesive; sand is very fine-grained.
70.5-77.0	SILTY SANDSTONE-SANDSTONE	--	Light gray (N 7), very fine-grained.
77.0-78.0	GRAVELLY SAND	GP	Varicolored, sand is fine- to medium-grained, subangular to subrounded; gravel consists of chert and limy nodules, fine- to medium-grained, subangular to subrounded; some pyrite.
78.0-97.0	SILTY SANDSTONE	--	Light gray (N 7), very fine-grained. At 82 feet, gravel stringer. At 85.5 feet, gravel stringer.

TOTAL DEPTH OF BOREHOLE: 97 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-6

LITHOLOGIC LOG OF MONITOR WELL P-13US

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0-0.5	TURF		
0.5-8.5	CLAYEY SILT	ML	Very dark grayish brown (2.5 Y 3/2) 85 percent silt, 15 percent clay, soft, plastic, cohesive, trace fine sand; grading to black (2.5 Y N/2); 50 percent silt, 50 percent clay, soft to firm, very plastic, cohesive.
8.5-11	GRAVEL/CLAYEY SILT	GM-GC	Mottled gravel with coarse sand, very angular to subround; interbedded with light olive brown (2.5 Y 5/4) 85 percent silt, 15 percent clay, plastic, cohesive.
11-27	SILT	MH	White (2.5 Y 8/2) silt, very soft, cohesive, trace very fine to fine sand. At 13 feet calcareous stringer, firm to hard, brittle.
27-54.5	CLAYEY SILT/LIMESTONE	--	Gray (2.5 Y 5/2) 85 percent silt, 15 percent clay, soft to firm, plastic, slightly cohesive, reaction with HCl, interbedded with gray (2.5 Y 5/2). Limestone, firm to hard, brittle. Clayey silt and limestone becoming harder with depth. At 29 feet thin, white, soft, limestone interbeds containing shell fragments.
54.5-61	SAND	SW	Gray (2.5 Y 5/2) sand, mottle gray to tan, very fine- to medium-grained, dense, friable.

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-6 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-13US

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
61-64	CLAYEY SILT	ML	Gray (2.5 Y 5/2) 60 percent silt, 40 percent clay, very plastic, grading to silt with clay, trace very fine sand, slight plasticity. At 64 feet, back to clayey silt as above.

TOTAL DEPTH OF BOREHOLE: 64 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by mud rotary

TABLE E-7

LITHOLOGIC LOG OF MONITOR WELL P-15U

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 15.0	CLAY	CH	Dark gray (N 2 to N 3), soft, plastic, sticky, trace fine sand.
15.0 - 18.0	SANDY CLAYEY SILT	ML	Grayish orange (10 YR 7/4), soft plastic.
18.0 - 22.0	SILTY SAND	SM	Varicolored, sand is fine to coarse, angular, silt is orange (10 YR 7/4), and approximately 10 percent.
22.0 - 42.0	SILTY SAND WITH GRAVEL	SM	Grayish orange (10 YR 7/4), sand is medium- to coarse-grained, silt content is approximately 20 percent, gravel consists of angular fossil fragments.
42.0 - 48.0	GRAVELLY CLAY	CL	Grayish orange (10 YR 7/4), clay is soft and sticky, gravel is fine- to medium-grained, subangular to rounded limestone, approximately 15 percent.
48.0 - 53.0	SANDY GRAVELLY SILT	ML	Grayish orange (10 YR 7/4), gravel is fine-grained, rounded limestone; sand is medium to coarse-grained limestone and silica, sand and gravel are approximately 30 percent of matrix.
53.0 - 55.0	SANDY GRAVEL	GM	Varicolored, fine- to medium-grained, angular, gravel is mostly shell fragments, sand is medium- to coarse-grained, angular to rounded.

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-7 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-15U

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
55.0 - 61.0	CLAYEY GRAVEL WITH FOSSILIFEROUS LIMESTONE	--	Core sample, 20 percent recovery, top six inches is clayey gravel, grayish orange (10 YR 7/4), soft, sticky, gravel is coarse-grained to cobble size consisting of limestone and chert, bottom six inches is fossiliferous limestone, white with reddish oxidation staining, some gray inclusions.
61.0 - 67.0	LIMESTONE WITH CLAY AND SILTY SANDSTONE	--	Core sample (61 to 65 feet), 7 percent recovery, limestone is tan, fossiliferous, hard, clay is gray (N4 to N5), moderately plastic, dense, sticky, silty sandstone gray (N6), loose, friable.
67.0 - 69.0	SILTY SAND	SM	Light olive gray (ST 6/1), soft well sorted.
69.0 - 75.0	CLAY	CL	Medium gray (N 5), firm, plastic.
75.0 - 82.0	CLAYEY SAND SILTY	SM	Very light gray (N 8), soft, plastic, sand is very fine-grained, approximately 30 percent, clay is approximately 20 percent. At 78.0 to 82.0 feet, less clay, sand is approximately 40 percent of matrix.
82.0 - 89.0	SANDY SILTY	SM	Light olive gray (5 Y 6/1), soft nonplastic, sand is very fine-grained.
89.0 - 95.0	SANDY CLAYEY SILT	ML	Very light gray (N 8), soft, moderately plastic; sand is very fine-grained.

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-7 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-15U

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
95.0 - 122	SAND	SP	Milky white, soft, fine-grained, well-sorted, lightly cemented. (Grouted from 92.0 to 122 feet; total depth of well is 92 feet).

TOTAL DEPTH OF BOREHOLE: 122 Feet

*Unified Soil Classification System
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**Drilled by mud rotary

TABLE E-8

LITHOLOGIC LOG OF MONITOR WELL P-15US

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 10.0	CLAY	CH	Dark gray (N 3), firm, sticky, cohesive.
10.0 - 12.0	SILTY CLAY	CL	Dark olive gray (5 Y 6/1), firm, cohesive, trace medium-grained sand.
12.0 - 20.0	CLAYEY SILT	ML	Grayish orange (10 YR 7/4), firm, cohesive, some medium- to coarse-grained sand.
20.0 - 32.0	SILTY SANDY GRAVEL - GRAVELLY SAND	GM-SP	Grayish orange (10 YR 7/4), gravel is fine- to medium-grained, angular, consisting mainly of fossil fragments, sand is fine- to coarse-grained, angular to rounded.
32.0 - 42.0	SANDY GRAVELLY SILTY CLAY	SP	Dark yellowish orange (10 YR 6/6), soft, sticky, gravel is medium- to fine-grained consisting mainly of rounded limestone.
42.0 - 52.0	SILTY CLAY WITH SAND	CL	Yellowish orange (10 YR 6/6), soft sticky, trace fine- to medium-grained sand.
52.0 - 61.0	SANDY GRAVEL	GP	Varicolored, gravel is rounded with angular shell fragments, sand is fine to coarse, subangular.
61.0 - 63.0	LIMESTONE	--	Medium gray to white (N 6 to N9), hard.
63.0 - 68.0	SANDY SILT	SM	Very little cutting at surface, based on drilling rate and log from P-15U.

*Unified Soil Classification System ASTM D-2487

**Drilled by flight auger

TABLE E-8 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-15US

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
68.0 - 69.0	SILTY CLAY	CL	Light olive gray (5 Y 6/1), soft plastic, moderately cohesive.

TOTAL DEPTH OF BOREHOLE: 69 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by flight auger

TABLE E-9

LITHOLOGIC LOG OF MONITOR WELL P-16US

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0 - 4.0	SANDY CLAY	CL	Yellow brown (10 YR 5/4), cohesive, plastic, sand is medium to coarse-grained, predominantly white, opaque grains.
4.0 - 19.5	SILTY CLAY/ CLAYEY SILT	CL/ML	Grayish orange (10 YR 7/4), cohesive, moderately plastic, soft.
19.5 - 28.0	GRAVELLY CLAY	CL	Clay is gray orange (10 YR 7/4), cohesive, moderately plastic, soft, gravel is predominantly sandstone class.
28.0 - 56.0	SILTY CLAY	CL	Light brown (5 YR 6/4), cohesive, plastic, soft, trace gravel up to 1/4 inch.
56.0 -59.75	SANDY GRAVEL	GW	Varicolored, medium- to coarse-grained sand, fine- to coarse-grained gravel.
59.75 -62.0	FOSSILIFEROUS LIMESTONE	--	Gray (N 8 to N 4), hard, well cemented.
62.0 -64.75	CLAYEY SANDSTONE	--	Gray (N 3), fine-grained sandstone, poorly cemented, interbeds of sandy clay.
64.75 -69.0	CLAY	CL	Gray (N 8), moderately plastic, some sand, clayey sandstone interbeds, sand and sandstone interbeds decreasing with depth.

TOTAL DEPTH OF BOREHOLE: 69.0 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-10

LITHOLOGIC LOG OF MONITOR WELL P-17US

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 2.0	CLAY	CH	Black (N 2), very plastic, very cohesive.
2.0 - 7.0	SANDY SILT	ML	Brown, (10 R 3/4), slightly cohesive, nonplastic; sand approximately 15 percent, varicolored, angular to subangular grains, medium to coarse grains.
7.0 - 44.5	INTERBEDDED SILTY CLAY - CLAY SILT	CL	Gray orange (10 YR 7/4) moderately plastic, moderately cohesive.
44.5 -46.75	SAND	SW	Varicolored, medium- to very coarse-grained, rounded to well rounded.
46.75 -52.5	SANDY GRAVEL	GP	Varicolored, medium to very coarse sand, fine- to very coarse-grained gravel, rounded to well rounded grains.
52.5 - 54.0	FOSSILIFEROUS	--	Gray (N 6) brittle angular shell fragment (Walnut Formation).
54.0 -58.25	MASSIVE LIMESTONE	--	Gray (N 3 to N 8), brittle angular fragments, some organic streaks, gray N3.
58.25 -60.5	SANDSTONE	SW	Gray (N 4 to N 7) clay is slightly cohesive, slightly plastic; sand is very fine-grained, well rounded.

TOTAL DEPTH OF BOREHOLE: 71 Feet

*Unified Soil Classification System
ASTM D-2487

TABLE E-11

LITHOLOGIC LOG OF MONITOR WELL P-18US

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0-3.0	SILT	MH	Moderate brown (5 YR 3/4), noncohesive.
3.0-4.0	SILTY CLAY	CL	Moderate brown (5 YR 3/4), moderately cohesive, nonplastic, sticky.
4.0-20.0	SANDY SILT-SILTY SAND	SM	Light brown (5 YR 5/6), sand is fine-grained; silt is noncohesive. At 6.0 feet, some clay and chert nodules, moderately cohesive. At 20.0 feet, some black to brown black organic matter (N 1 to 5 YR 2/1).
20.0-36.0	SILTY CLAY-CLAYEY SILT	CK/ML	Light brown (5 YR 5/6), slightly cohesive, sticky, nonplastic. At 27.0 feet, trace buff colored clay, slightly cohesive, nonplastic.
36.0-43.0	SILTY SAND-CLAYEY SAND	SM/SC	Light brown (5 YR 5/6), sand is fine grained; clay is slightly cohesive, sticky.
43.0-45.5	SANDY GRAVEL	SW	Varicolored, gravel is fine to medium grained, angular to subrounded; sand is fine to coarse grained, angular to subrounded.
45.5-60.5	FOSSILIFEROUS LIMESTONE	--	Varicolored gray (N 5 to N8), dense, dry, very well cemented. Oyster fossils.
60.5-67.0	SANDSTONE	--	Gray (N 7), very fine-grained, very well cemented, well rounded. Some pyrite.

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-11 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-18US

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
67.0-68.0	CLAYSTONE	--	Gray (N 5 to N7), moderately cemented.
68.0-73.5	SANDY CLAY-SANDSTONE	--	Gray (N 5 to N7), fine-grained, loose. At 73.0 feet, abundant organic matter, black (N 1).
73.5-75.0	SILTY CLAY	CL	Gray (N 7) cohesive, nonplastic.

TOTAL DEPTH OF BOREHOLE: 75 Feet

*Unified Soil Classification System
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**Drilled by mud rotary

TABLE E-12

LITHOLOGIC LOG OF MONITOR WELL P-19US

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0-19.0	SANDY SILT	SM	Moderate reddish brown (10 YR 4/6), moderately cohesive, moderately plastic.
			At 3.0 feet, color change to light brown (5 YR 6/4) more sand, trace chert nodules.
19.0-31.0	SANDY SILT-SILTY SAND	SM	Grayish orange (10 YR 7/4), nodules, of quartz, chert, and limestone.
31.0-46.0	CLAYEY SILT	ML	Grayish orange (10 YR 7/4), noncohesive, sticky; trace sand.
			At 45.0 feet, more sand.
46.0-51.5	GRAVELLY SAND	SW	Varicolored, sand is medium- to coarse-grained, angular to subrounded; gravel is fine-grained, angular to subrounded.
51.5-56.0	FOSSILIFEROUS LIMESTONE	--	Gray (N 4 to N 7), dense, dry. Oyster fossils.
56.0-58.0	CLAYEY SANDSTONE	--	Medium gray (N 5), sand is fine-grained; clay is noncohesive.
58.0-69.5	SANDSTONE	--	Medium gray (N 5), very fine- to fine-grained.
69.5-70.5	SANDY CLAY	SC	Medium gray (N 5), clay is sticky, slightly cohesive; sand is fine-grained.

TOTAL DEPTH OF BOREHOLE: 70.5 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-13

LITHOLOGIC LOG OF MONITOR WELL P-22M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL
0 - 4.0	FILL	SP	Varicolored, sand, gravel, clay, dry, no odor.
4.0 - 6.0	SANDY CLAY	CL	Gray (N 4), moderately cohesive, slightly plastic, wet, slight to strong solvent odor.
6.0 - 31.0	LIMESTONE	--	Gray (N 3 to N 8) brittle angular fragment, shell fragments, Walnut Formation.
31.0 - 55.0	SANDY CLAYSTONE - CLAYEY SANDSTONE	SW	Sand is whitish gray (N 7 to N 8) very fine-grained, well rounded, very well cemented; clay is gray, (N 4 to N 6), hard, moderately plastic, slightly cohesive, some shell fragments noted (Paluxy Formation).
55.0 - 61.0	SAND	SW	Whitish (N 8), very fine-grained, well rounded.
61.0 - 80.0	SILTY CLAY	ML	Bluish white (5B 9/1), slightly cohesive, moderately plastic; minor fine sand interbeds.
80.0 -133.0	SAND	SW	Grayish white (N 8), very fine-grained, well rounded.
133.0-136.0	CLAY	CH	Gray (N 5 to N 7), cohesive, plastic.

TOTAL DEPTH OF BOREHOLE: 136 Feet

*Unified Soil Classification System
ASTM D-2487

TABLE E-14

LITHOLOGIC LOG OF MONITOR WELL P-24M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 26.5	FOSSILIFEROUS LIMESTONE	--	Light yellowish gray to light gray (5 Y 8/1 to N5 to N 8), weathered clay interbeds. At 18 feet, darker gray (N 3 to N 5). At 22.5 feet, harder layer, white. At 25-26.5 feet, more silt and clay, hard.
26.5 - 56.0	SILTY SAND	ML	Dark gray (N 5), very fine-grained, well sorted; trace clay, dark gray (N 3 to N 4). At 40-41 feet, limestone, hard, very light gray to medium gray (N 5 to N 8). At 44-46 feet, hard layer.
56.0 - 72.0	CLAYEY SILT	CL	Medium gray (N 6), slightly cohesive; trace sand, trace lignite. At 60 feet, silty clay, more sticky, trace sand, color change to light bluish gray (5 B 7/1). At 61 feet, more sand. At 68 feet, some clay is form, some slightly cohesive, color change to light gray (N 7). At 72 feet, more sand.

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-14 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-24M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
72.0 -131.5	SAND	SP	Pinkish gray (5 YR 8/1), very fine- to fine-grained, well sorted, well rounded, slightly cemented. At 86.0-86.5 feet, lignite layer. At 90 feet, grading to very fine sand. At 111-112 feet, lignite layer. At 112-130 feet, trace silt and pyrite.
131.5-134.0	SILTSTONE-CLAYSTONE	CL	Light bluish gray (5 B 7/1), moderately cemented, interbedded harder layers.

TOTAL DEPTH OF BOREHOLE: 134 Feet

*Unified Soil Classification System
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**Drilled by mud rotary

TABLE E-15

LITHOLOGIC LOG OF MONITOR WELL P-24U

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 25.0	FOSSILIFEROUS LIMESTONE	--	Light yellowish gray to light gray (5 Y 8/1 to N 5 to N 8); clay interbeds, firm, cohesive. At 17 feet, color grades to medium gray (N 4 to N 5), harder. At 18 feet, color grades to white to light gray (N 5 to N 9). At 23 feet, trace dark gray (N 4 to N 5), claystone-shale. At 23.5-25 feet; siltstone, medium to light gray (N 5 to N 8).
25.0 - 56.0	SILTY SAND-SANDY SILT	ML	Medium light gray (N 6), very fine-grained, soft, well sorted. At 49.5 feet, thin, hard layer, cuttings appear to be limestone. At 50-56 feet, intermittent, harder layers, trace lignite.
56.0 - 61.0	CLAYEY SILT	CL	Pale green to yellowish gray (5 BG 7/2 to 5 Y 8/1), soft, noncohesive.

TOTAL DEPTH OF BOREHOLE: 61 Feet

*Unified Soil Classification System ASTM D-2487

**Drilled by mud rotary

TABLE E-16

LITHOLOGIC LOG OF MONITOR WELL P-25M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 32.0	SANDY SILT	ML	Grayish orange (10 YR 7/4), soft, noncohesive; sand is very fine- to medium-grained, angular to rounded, some grains appear to be limestone; mild reaction with HCl.
32.0 - 57.5	FOSSILIFEROUS LIMESTONE WITH SHALE	--	Medium gray (N 4 to N 6), fossils are oyster shell fragments. At 32-34 feet, weathered shell agglomerate, grayish orange (10 YR 7/4); some medium to coarse sand, varicolored, rounded. At 34-35 feet, harder. At 35-39 feet, shale-limestone interbeds; some medium sand grains. At 39-40 feet, more shale, dark gray (N 3). At 40-43 feet, harder, lighter gray. At 43-43.5 feet, more shale, darker gray. At 43.5-44.5 feet, harder, more shell fragments. At 44.5-47 feet, hard limestone-shale interbeds. At 47-49 feet, softer, more shaly bedded; some silty clay. At 49-56 feet, hard limestone-shale interbeds.

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**Drilled by mud rotary

TABLE E-16 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-25M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
			At 56-57.5 feet, silt, yellowish gray (5 Y 8/1), soft, noncohesive, some fine sand.
57.5 - 58.5	CLAYEY SILT	CL	Medium gray (N 5), soft, moderately cohesive.
58.5 - 64.0	SANDY GRAVELLY SILT/ SANDY GRAVELLY CLAY	GM/GC	Medium to light gray (N 5 to N 6), sand is fine- to medium-grained; gravel is fine, angular; some layers of shale.
			At 59 feet, shale appears to have an oily matrix.
64.0 - 66.0	SILTY SANDY GRAVEL	GM	Varicolored, fine-grained, poorly sorted, angular; sand is very fine- to fine-grained; some clay.
66.0 - 69.0	SANDY SILT/ SANDY CLAY	SM/SC	Olive gray (5 Y 4/1), soft, moderately cohesive; sand is fine, 10-20 percent.
			At 67-69 feet, color change to medium gray (N 5).
69.0 - 74.0	CLAYEY SILT/ SANDY SILT	CL/SM	Medium light gray (N 6), interbedded.
74.0 - 76.0	CLAYSTONE/ SILTSTONE	--	Light olive gray (5 Y 6/1), moderately cemented; soft, moderately cohesive; some fine sand.
76.0 - 80.0	SILTY CLAY	CL	Light olive gray (5 Y 6/1), soft, moderately cohesive; some fine to very fine sand.
80.0 - 82.0	CLAY	CL	Light olive gray (5 Y 6/1), soft, cohesive, more dense with depth; trace fine sand.

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**Drilled by mud rotary

TABLE E-16 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-25M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
82.0 - 91.5	SANDY SILTY CLAY	CL	Light olive gray (5 Y 6/1), soft, moderately cohesive; 10 percent sand is fine- to medium-grained, angular to rounded. At 82-83 feet, lignite layer. At 85 feet, color change to light greenish gray (5 G 8/1). At 85.5 feet, very fine sandstone or shale layer.
91.5 -100.0	SANDY SILT/ SILTY SANDSTONE	SM	Pinkish gray (5 YR 8/1), very fine- to fine-grained, lightly cemented, friable; cemented sandstone is higly reactive with HCl.
100.0-111.0	SAND	SP	Light gray (N 7 to N 8) to pinkish gray (5 YR 8/1), very fine- to fine-grained, well sorted, rounded to well rounded, clean, soft. At 105-106 feet, harder layer, probably sandstone.
111.0-125.0	SILTY CLAY/ CLAYEY SILT	ML/CL	Light greenish gray (5 G 8/1) to light olive gray (5 Y 6/1), slightly firm to soft, moderately cohesive; some lignite and fine sandstone.
125.0-158.0	SILTY SAND	SM	Pinkish gray (5 YR 8/1), very fine-grained, soft, loose, clean. At 142 feet, some clay. At 154 to 155 feet, sand is coarser but still fine-grained, well sorted and rounded, less silt.

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TABLE E-16 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-25M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
158.0-160.0	SILTY CLAY	CL	Light bluish gray (5 B 5/1), slightly cohesive, trace sand.

TOTAL DEPTH OF BOREHOLE: 160 Feet

*Unified Soil Classification System
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**Drilled by mud rotary

TABLE E-17

LITHOLOGIC LOG OF MONITOR WELL P-25U

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 6.0	SILTY SAND	SM	Light brown (5 YR 5/6), fine- to medium-grained; some weathered caliche nodules.
6.0 - 12.0	SANDY SILT	ML	Same color; trace clay. At 10 feet, color change to grayish orange (10 YR 7/4); less sand and more clay.
12.0 - 24.0	CLAYEY SILT	CL	Grayish orange (10 YR 7/4), slightly sticky; trace sand.
24.0 - 32.0	SANDY SILT	SM	Same color; sand is fine- to medium-grained.
32.0 - 33.0	GRAVELLY CLAY	GC	Same color, noncohesive; gravel is varicolored, fine-grained, angular to subrounded.
33.0 - 35.0	GRAVELLY SAND	GD	Varicolored, fine- to coarse-grained, angular to subrounded grains consisting of weathered limestone, chert, and caliche; gravel is fine-grained; some silt and clay.
35.0 - 37.0	LIMEY SHALE	--	Dark gray (N 3), weathered; clay interbeds; appears to have an oily based matrix; soft and easily friable. At 37 feet, some fossil fragments (oyster shells).

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**Drilled by mud rotary

TABLE E-17 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-25U

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
37.0 - 44.0	FOSSILIFEROUS LIMESTONE	--	Light gray (N 6 to N 7), dense, fossils are oyster shell fragments; light greenish gray (5 G 8/1) clay interbeds. At 41.0 feet, limey sand, fine-grained. At 41.5 feet, very dense, but still some clay and silt interbeds; trace pyrite.
44.0 - 55.0	LIMEY SHALE	--	Medium gray (N 4 to N 6); clay interbeds.
55.0 - 57.5	LIMESTONE	--	Same color, dense, no visible fossils; some clay interbeds.
57.5 - 61.0	SILTY CLAY/ CLAYEY SILT	CL	Medium gray to greenish gray (N 5 to N 6 to 5 G 6/1), slightly cohesive, slightly sticky; some lignite.
61.0 - 68.0	SANDY SILT	ML	Medium gray (N 3 to N 5); sand is very fine-grained.
68.0 - 80.0	SILTY SAND	SM	Light gray (N 6 to N 7), very fine-grained. At 68.5 feet, thin lignite layer. At 74.0 feet, some clay. At 78.0 feet, sandstone, very fine-grained. At 79.0 feet, thin lignite layer. At 80.0 feet, some clay.

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TABLE E-17 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-25U

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
80.0 - 91.0	SILTY CLAY/ CLAYEY SILT	CL	Same as 57.5-61.0 feet. At 85-86 feet, sandstone, very fine-grained, strongly cemented. At 87-87.5 feet, trace pyrite. At 88.0 feet, whitish, silty sandstone.
91.0 -102.0	SANDY SILT/ SILTY SAND	ML	Light gray (N 6 to N 7), very fine-grained; silty content varies with depth; weakly cemented. At 100 feet, trace clay.
102.0-114.0	SAND	SP	Same color, very fine- to fine-grained, well sorted, subrounded to rounded, clean, soft. At 111-112, sandstone with pyrite; trace lignite.
114.0-115.0	SILTY CLAY/ CLAYEY SILT	CL	Greenish gray (5 GY 6/1), slightly cohesive; trace sand.

TOTAL DEPTH OF BOREHOLE: 115 Feet

*Unified Soil Classification System
ASTM D-2487

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TABLE E-18

LITHOLOGIC LOG OF MONITOR WELL P-26M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 2.0	ASPHALT AND FILL		
2.0 - 5.0	SILTY CLAY	CL	Brownish gray (5 YR 4/1), soft, moderately cohesive.
5.0 - 12.0	CLAYEY LIMESTONE	--	Pinkish gray to yellowish gray (5 YR 8/1 to 5 Y 8/1), weathered; some clay is grayish orange (10 YR 7/4), dense, cohesive. At 9.0 feet, less clay, more silt, color grades to grayish orange (10 YR 7/4).
12.0 - 21.0	LIMESTONE	--	Yellowish gray (5 Y 8/1), weathered to grayish orange (10 YR 8/1); some subrounded gravel, fine- to medium-grained. At 14 feet, dense, sticky clay interbeds, grayish orange to dark yellowish orange (10 YR 7/4 to 10 YR 6/6).
21.0 - 24.0	CLAYEY LIMESTONE	--	Same as 5.0-12.0 feet.
24.0 - 36.0	LIMEY SHALY CLAY	--	Medium bluish gray (5 B 5/1), slightly cohesive; shale is brittle, friable; highly reactive with HCl. At 30 feet, softer, color grades to darker gray (N 3 to N 4). At 33.5 feet, clay is more dense and sticky, more shale. At 36 feet, trace pyrite and shell fragments.

*Unified Soil Classification System ASTM D-2487

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TABLE E-18 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-26M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
36.0 - 41.0	FOSSILIFEROUS LIMESTONE	--	Medium gray (N 5 to N 6), hard, trace pyrite, shell fragments. At 38-40 feet, softer.
41.0 - 52.0	LIMEY SHALE	--	Grayish black to medium gray (N 2 to N 5), brittle; clay interbeds are soft and noncohesive; appears to have an oily matrix. At 41.5 feet, thin, white siltstone (chalk).
52.0 - 80.0	LIMESTONE WITH SHALE	--	Medium gray (N 3 to N 5), hard, some shell fragments; trace chert. At 56 feet, more shale. At 58 feet, more limestone. At 60 feet, more shale. At 60.5-63.5 feet, hard limestone, numerous shell fragments. At 63.5 feet, shale with silty clay interbeds, medium gray (N 4 to N 5) to light olive gray (5 Y 6/1). At 77 feet, some sandstone, very fine-grained, well cemented very light gray (N 7).

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ASTM D-2487

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TABLE E-18 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-26M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
80.0 - 94.0	CLAYEY SANDY SILT/ SILTY SANDY CLAY	--	Light olive gray (5 Y 6/1), soft, moderately cohesive, slightly sticky; sand is very fine-grained. At 86 feet, thin layer of light gray (N 7) very fine-grained sandstone, color grades to brownish gray (5 YR 4/1). At 87.5-88 feet, very fine-grained sandstone, light gray (N 7). At 89.5-90 feet, same as above. At 91 feet, thin lignite layer.
94.0 -106.0	CLAY	CH	Brownish gray (5 Y 6/1), dense, firm, cohesive, moderately plastic; trace lignite.
106.0-112.0	SILTY CLAY/ CLAYEY SILT	CL/ML	Brownish gray (5 Y 6/1), slightly cohesive; trace very fine-grained sand.
112.0-120.0	SAND	SP	Light gray (N 7 to N 8), very fine-grained, well sorted, soft, lightly cemented. At 112-114 feet, some silt. At 120 feet, thin lignite layer.
120.0-134.0	SANDY SILT/ SILTY SAND	SM	Light gray (N 7 to N 8), very fine-grained, noncohesive. At 120-122 feet, silt layer, brownish gray (5 Y 6/1).

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TABLE E-18 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-26M

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
134.0-167.0	SAND	SP	Yellowish gray (5 Y 8/1), very fine- to fine-grained, well sorted, rounded, lightly cemented. At 165-167 feet, well cemented.
167.0-171.5	SILTSTONE/ SILT	ML	Light greenish gray (5 G 8/1), soft, slightly cohesive; interbedded with harder white siltstone layers.

TOTAL DEPTH OF BOREHOLE: 171.5 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by mud rotary

TABLE E-19

LITHOLOGIC LOG OF MONITOR WELL P-26U

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
0.0 - 1.0	ASPHALT AND GRAVEL FILL	--	
1.0 - 5.0	SILTY CLAY/ CLAYEY SILT WITH WEATHERED LIMESTONE	--	Dark yellowish brown, soft, moderately cohesive. At 4.5 feet, color change to grayish orange (10 YR 7/4).
5.0 - 12.0	CLAYEY LIMESTONE	--	Very pale orange (10YR to 7/4), limestone is weathered; clay is soft, slightly cohesive. At 11.0 feet, softer, more clay, color change to dark yellowish orange (10 YR 6/6).
12.0 - 23.5	WEATHERED LIMESTONE/ CLAYEY GRAVEL	--	Grayish orange (10 YR 7/4); gravel is fine- to medium-grained, rounded, to subangular limestone; clay is soft, moderately cohesive.
23.5 - 26.0	LIMESTONE	--	Medium bluish gray (5 B 5/1), hard. At 24.5 feet, shale/clay interbeds, color grades to medium light gray (N 6).
26.0 - 36.0	LIMEY SHALE AND CLAY	--	Medium gray to medium light gray (N 5 to N 6), no visible fossils, moderate reaction with HCl. At 28-34 feet, softer. At 34 feet, harder.
36.0 - 46.0	FOSSILIFEROUS LIMESTONE	--	Medium light gray (N 6 to N 7), hard, brittle, shell fragments, strong reaction with HCl. At 42.0 feet, softer, more shale.

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TABLE E-19 (continued)
LITHOLOGIC LOG OF MONITOR WELL P-26U

DEPTH INTERVAL (feet below land surface)	SOIL TYPE	GROUP SYMBOL*	DESCRIPTION OF MATERIAL**
46.0 - 53.0	SHALE	--	Medium gray (N 5), brittle, hard, some shell fragments; some clay interbeds.
53.0 - 65.0	LIMESTONE	--	Medium light gray (N 6), hard, some shell fragments. At 55-57 feet, limestone and shale interbeds. At 57-65 feet, hard, more shell fragments.
65.0 - 75.0	SILTY CLAY	CL	Light olive gray (5 Y 6/1), moderately soft, moderately cohesive. At 72-75 feet, color change to medium light gray (N 6 to N 7), more firm and cohesive.
75.0 - 90.0	SANDY SILT	ML	Light olive gray to yellowish gray, soft, noncohesive; sand less than 10 percent, very fine-grained.
91.0 - 93.0	SILTY CLAY	CL	Brownish gray (5 YR 4/1), soft, slightly cohesive. At 91.0 feet, thin pyrite layer.

TOTAL DEPTH OF BOREHOLE: 93 Feet

*Unified Soil Classification System
ASTM D-2487

**Drilled by mud rotary

Appendix F

APPENDIX F

MONITOR WELL CONSTRUCTION DIAGRAMS

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APPENDIX F

MONITOR WELL CONSTRUCTION DIAGRAMS

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Figure

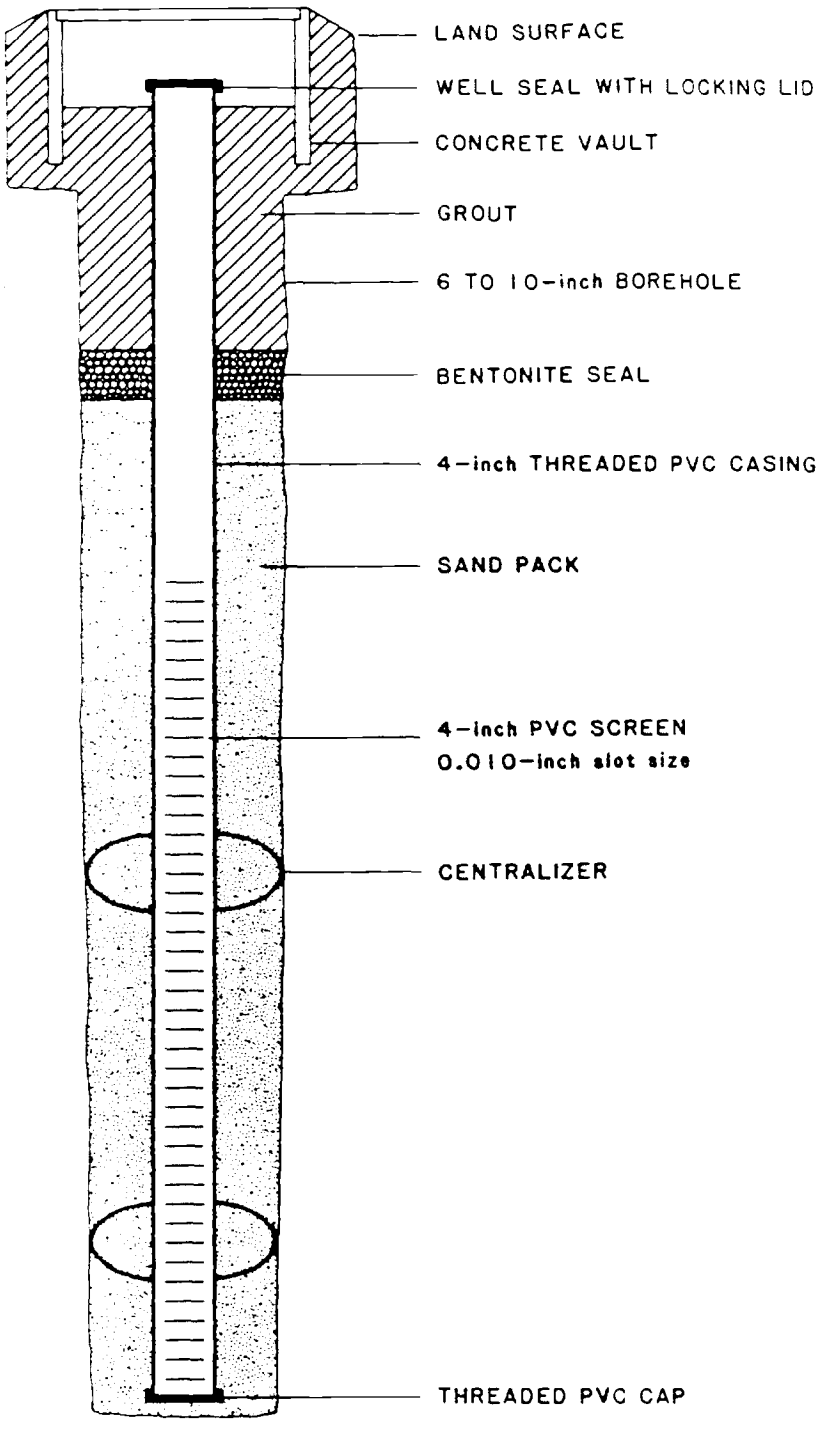


FIGURE F-1. GENERALIZED SCHEMATIC CONSTRUCTION DIAGRAM FOR UPPER ZONE MONITOR WELLS

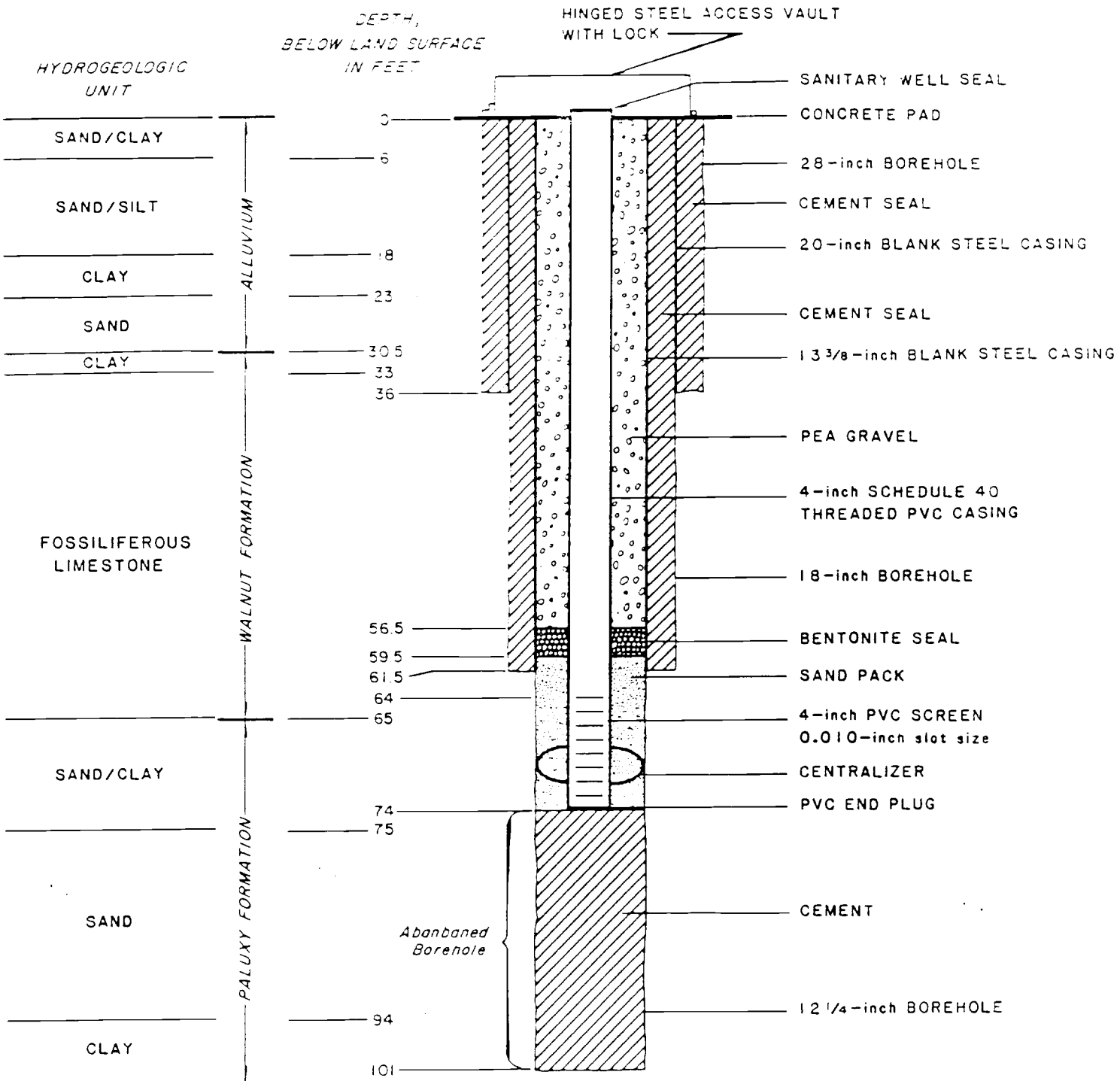


FIGURE F-2. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-5US

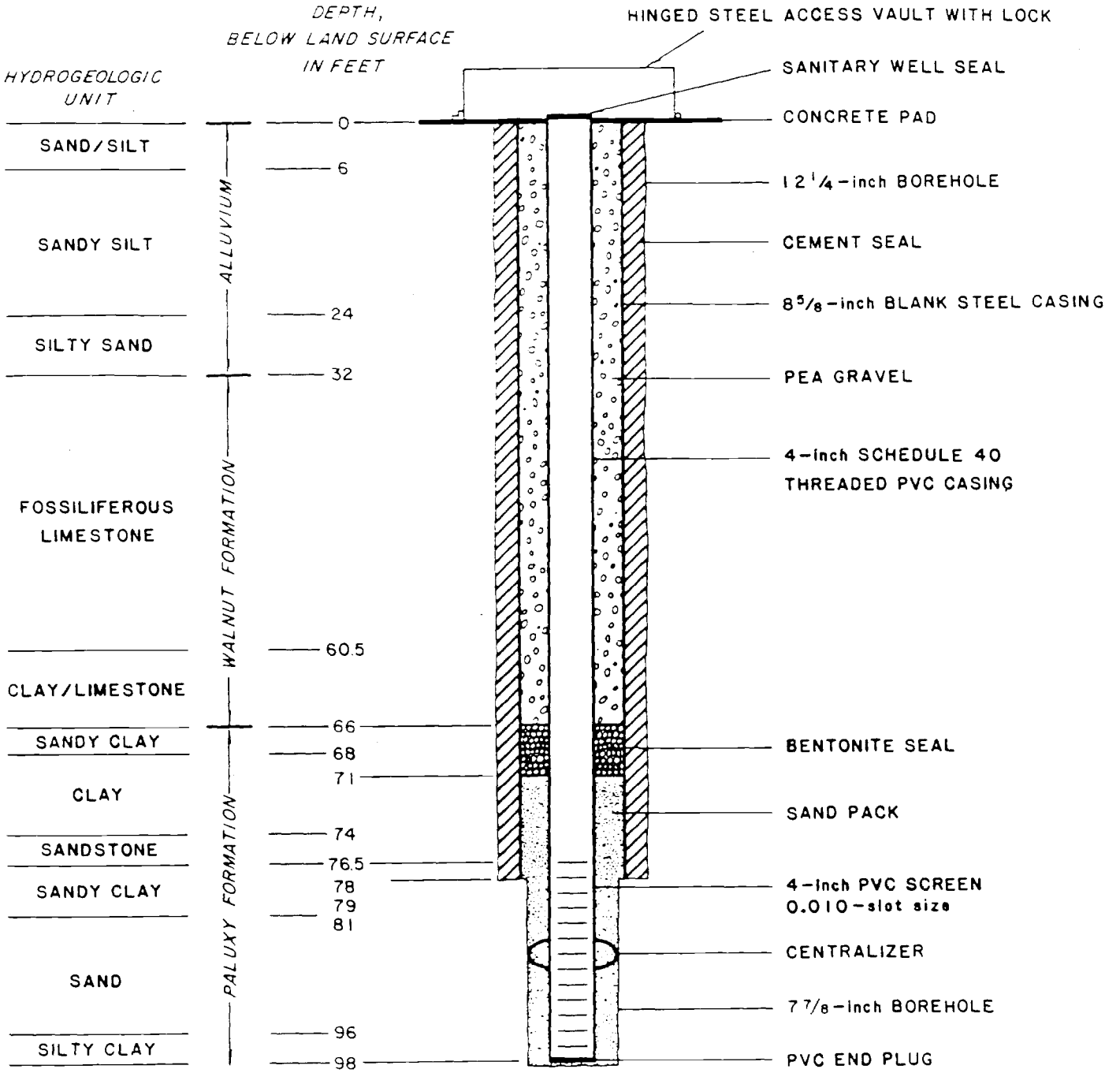


FIGURE F-3. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-5UN

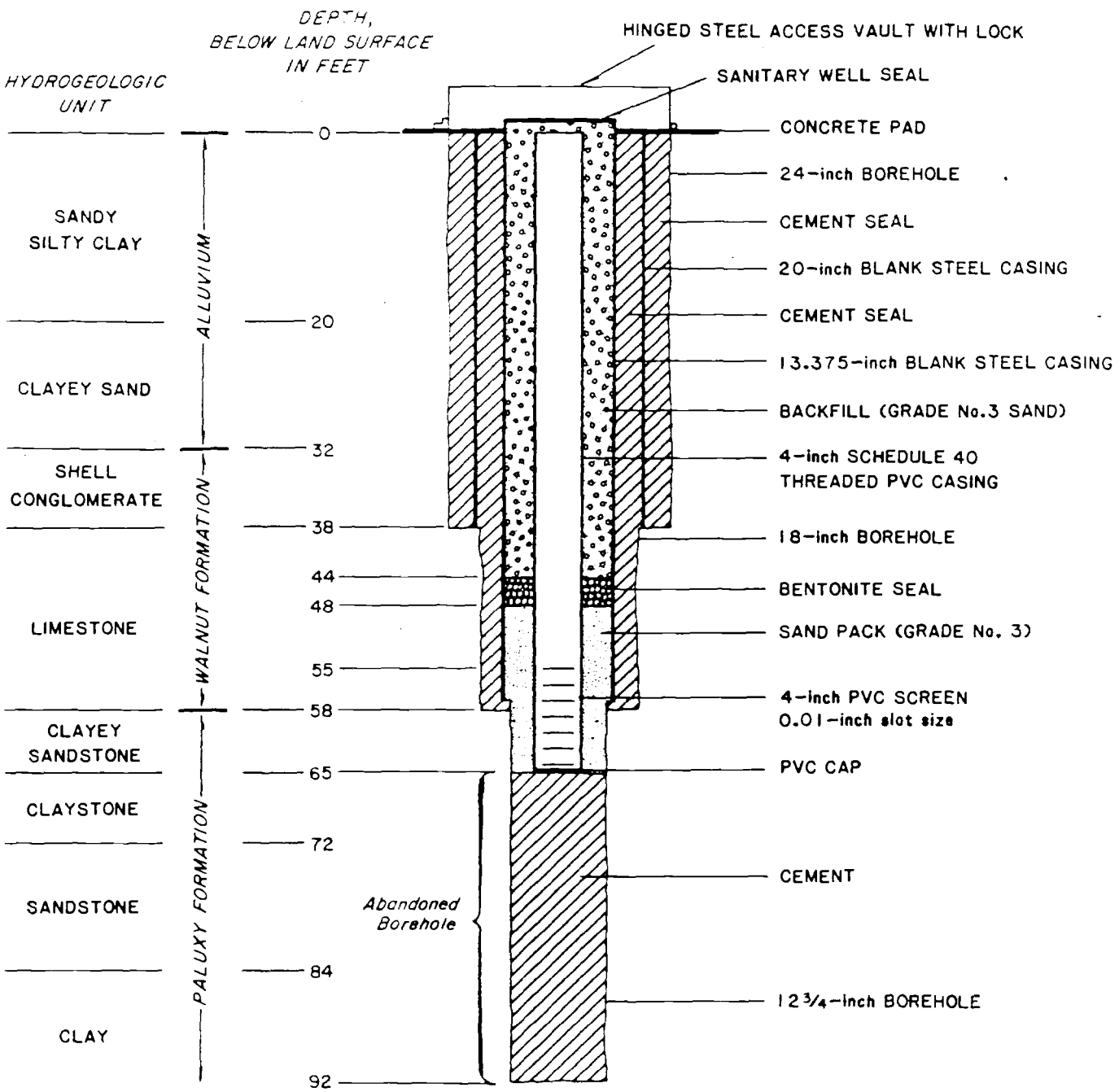


FIGURE F-4. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-8US

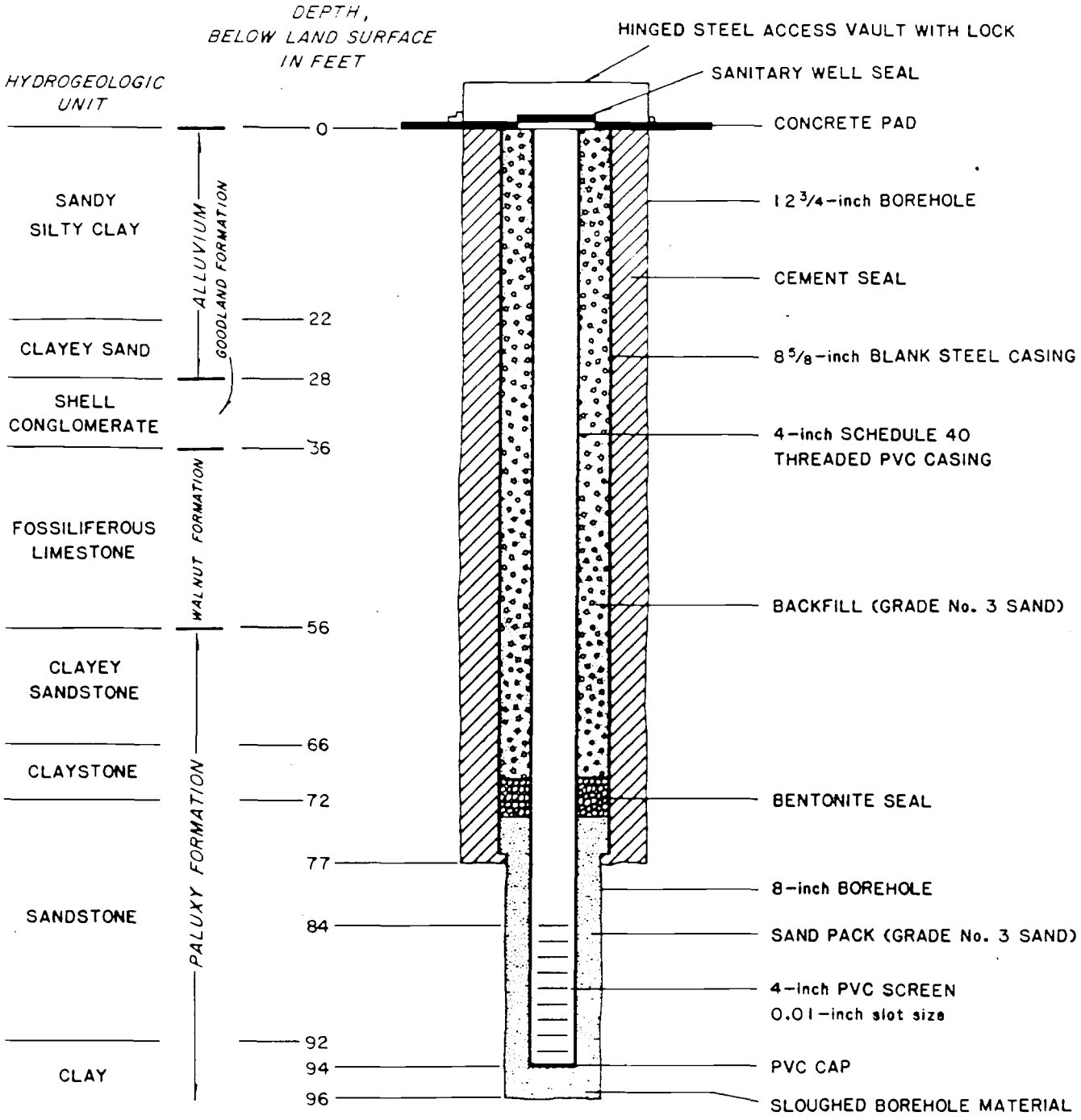


FIGURE F-5. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-8UN

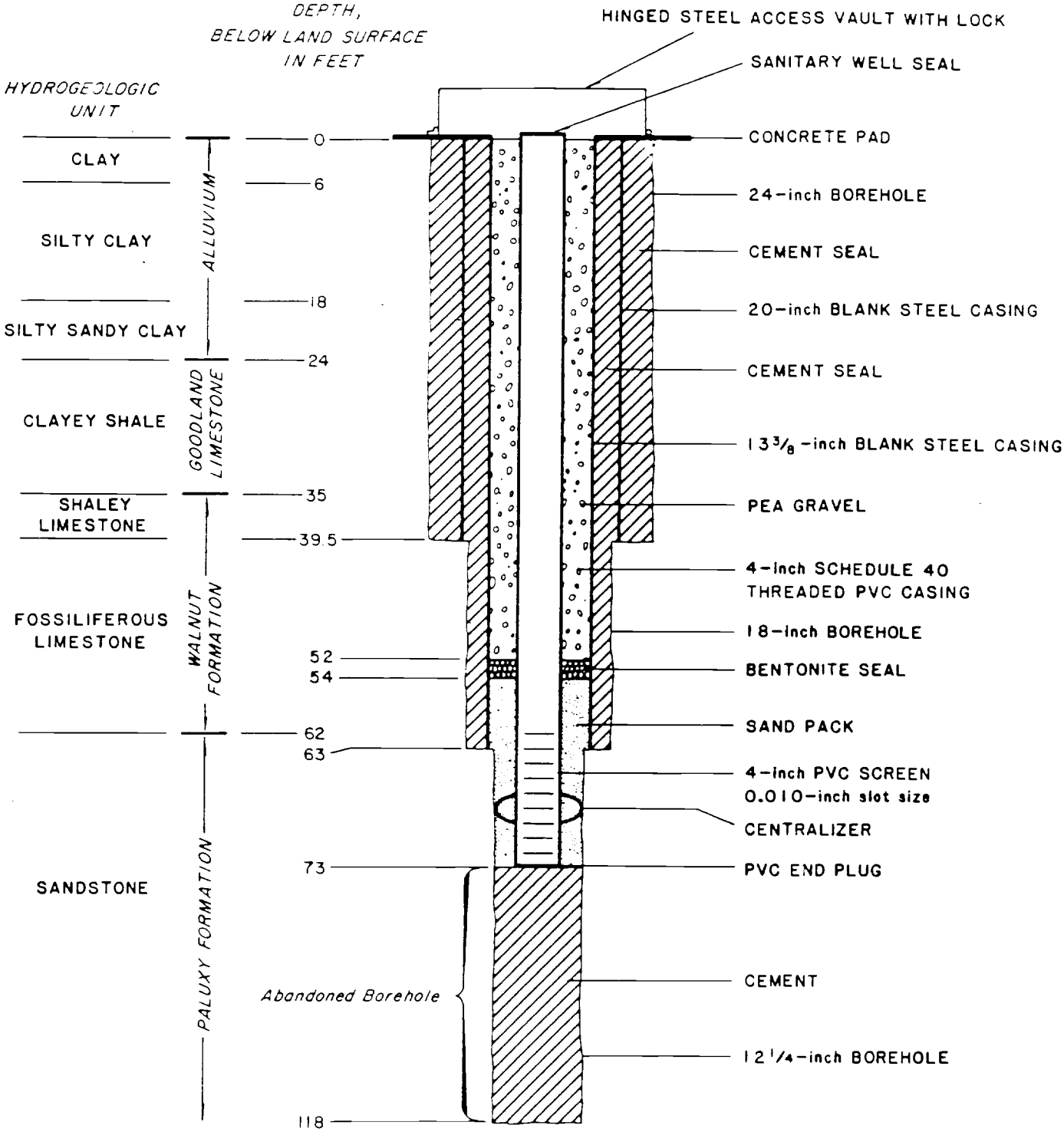


FIGURE F-6. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-9US

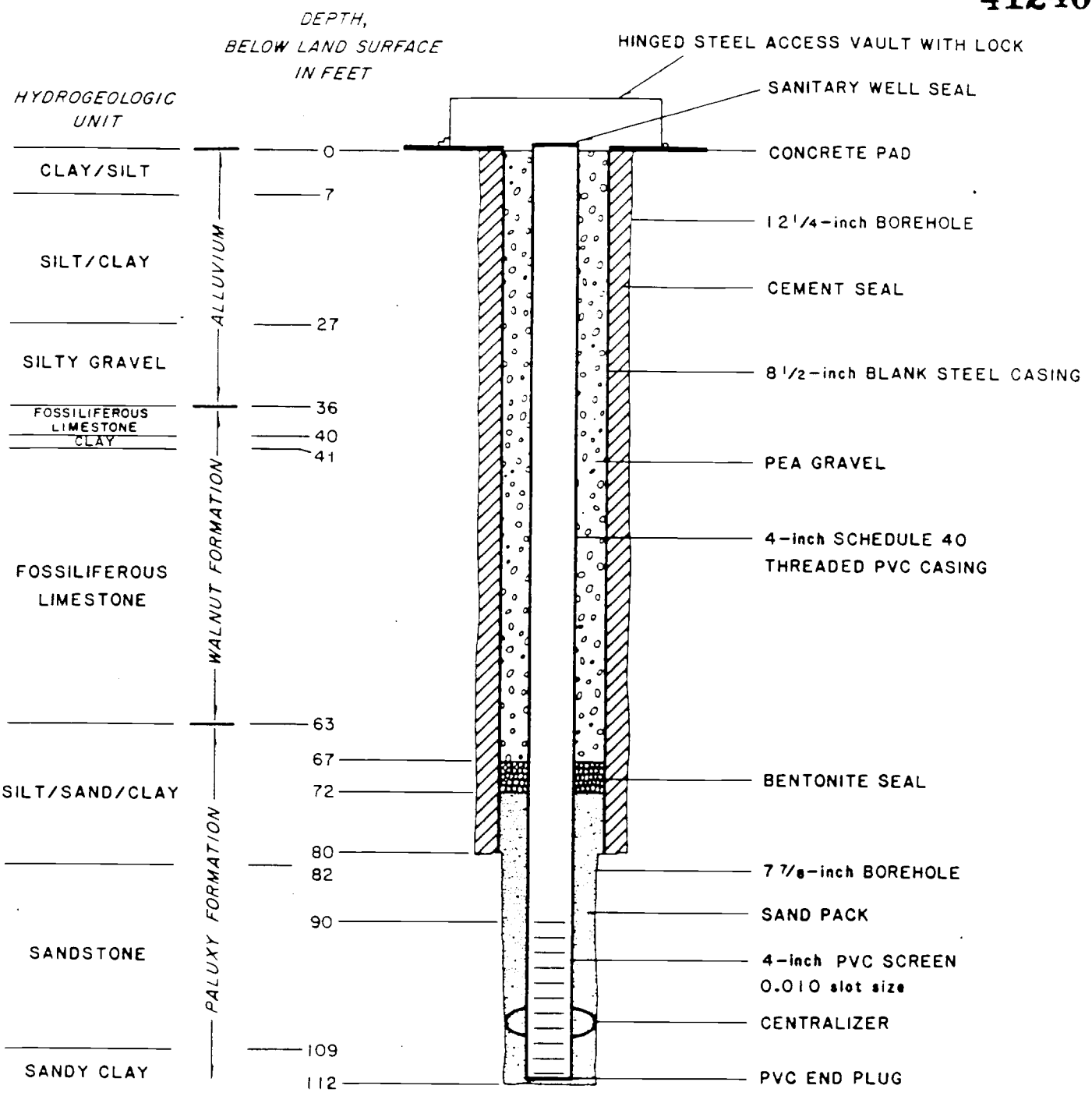


FIGURE F-7. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-9UN

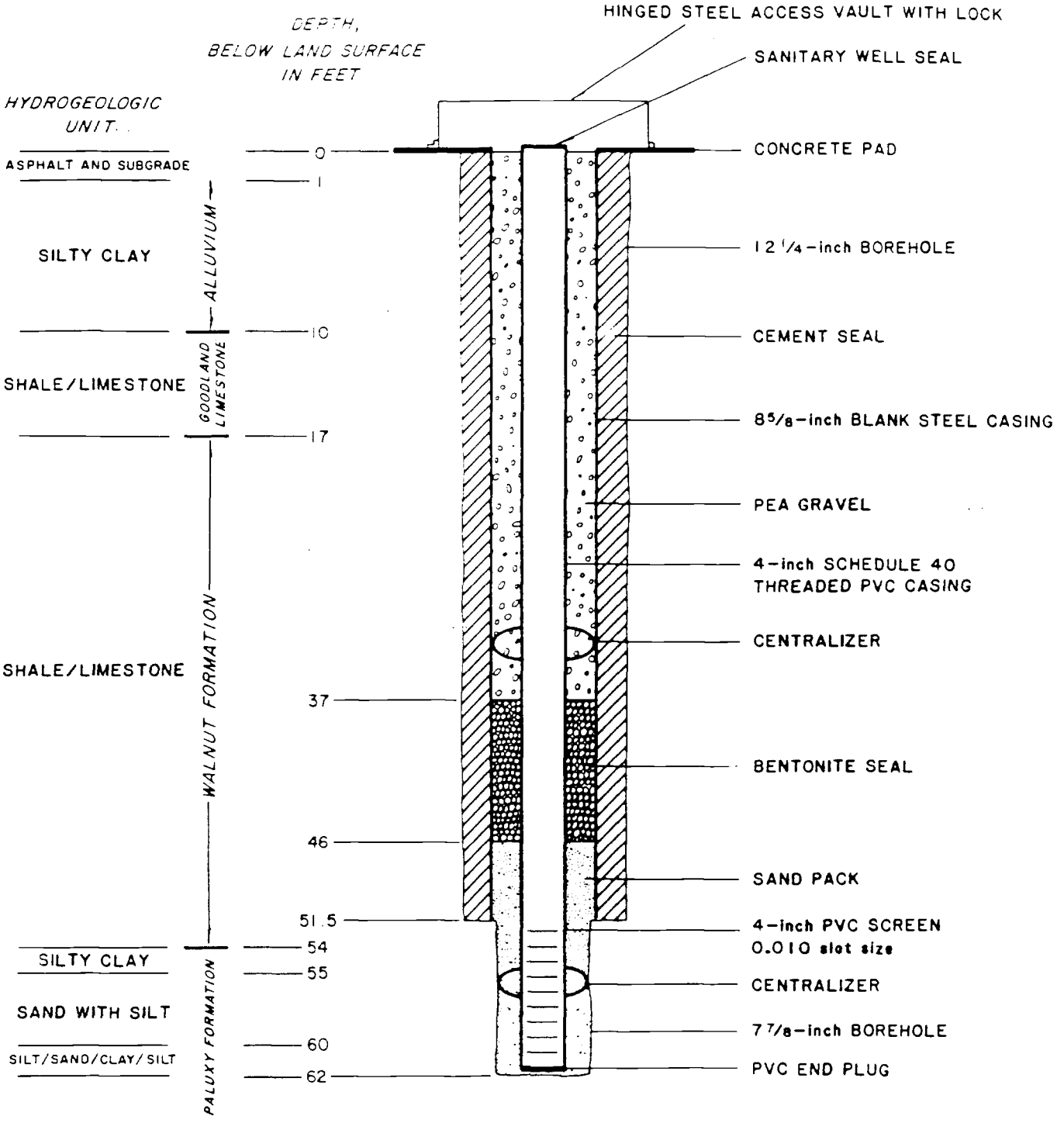
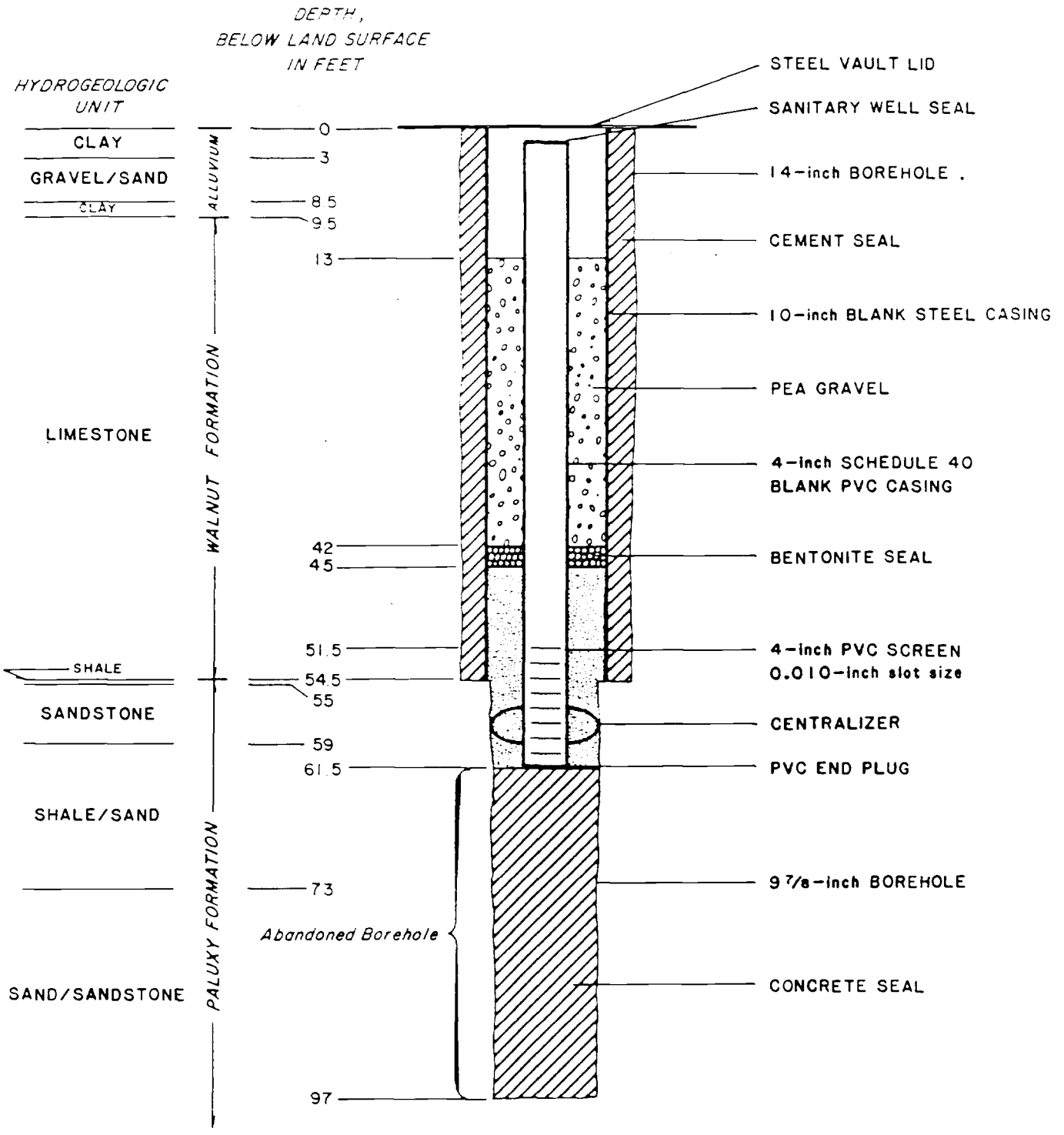


FIGURE F-8. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-111US



NOTE: HYDROGEOLOGIC UNITS BASED ON DRILLING LOG INTERPRETED BY U.S. ARMY CORPS OF ENGINEERS, SEPTEMBER 16, 1985

FIGURE F-9. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-12US

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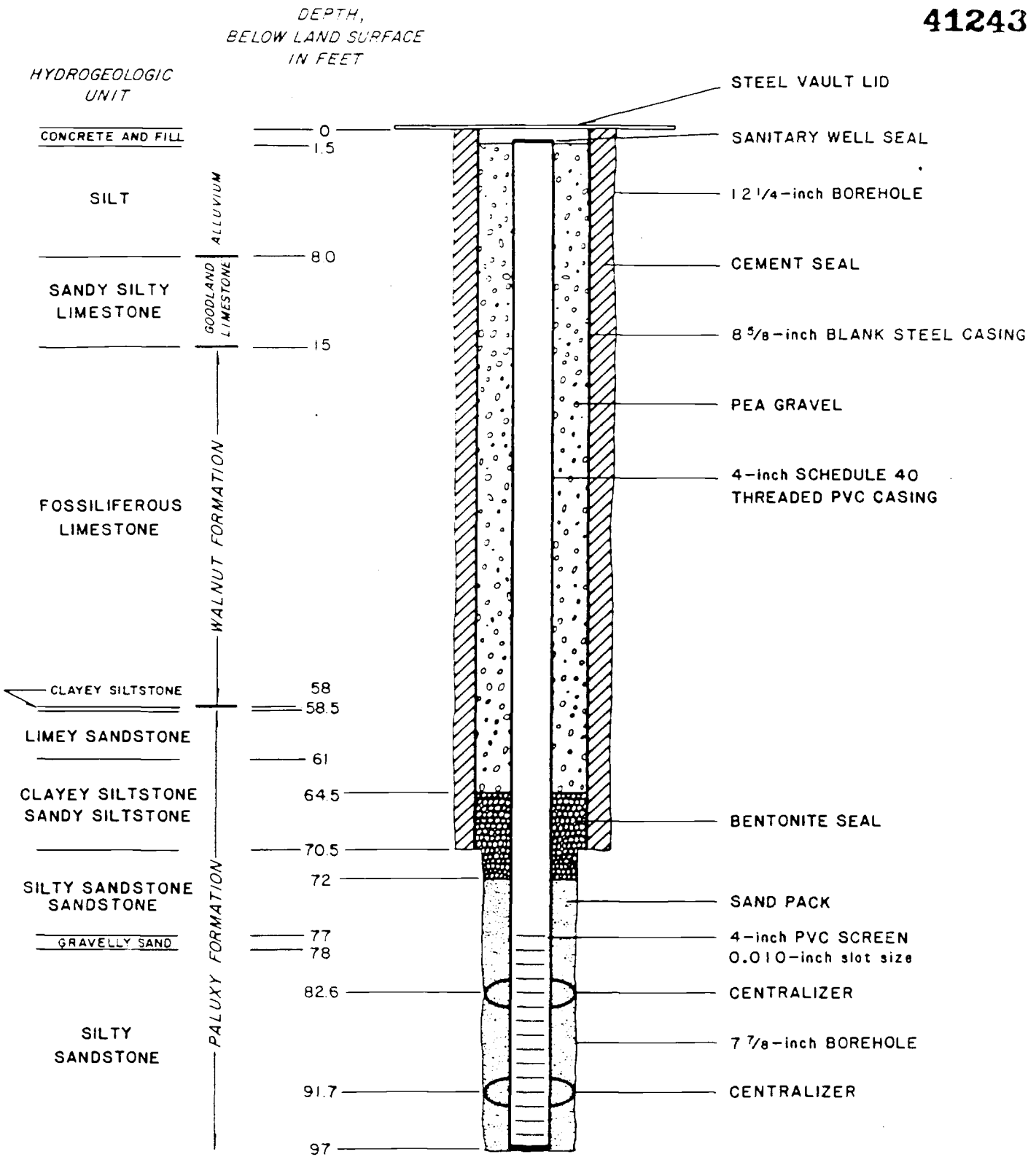

FIGURE F-10. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-12UN

HARGIS + ASSOCIATES, INC.

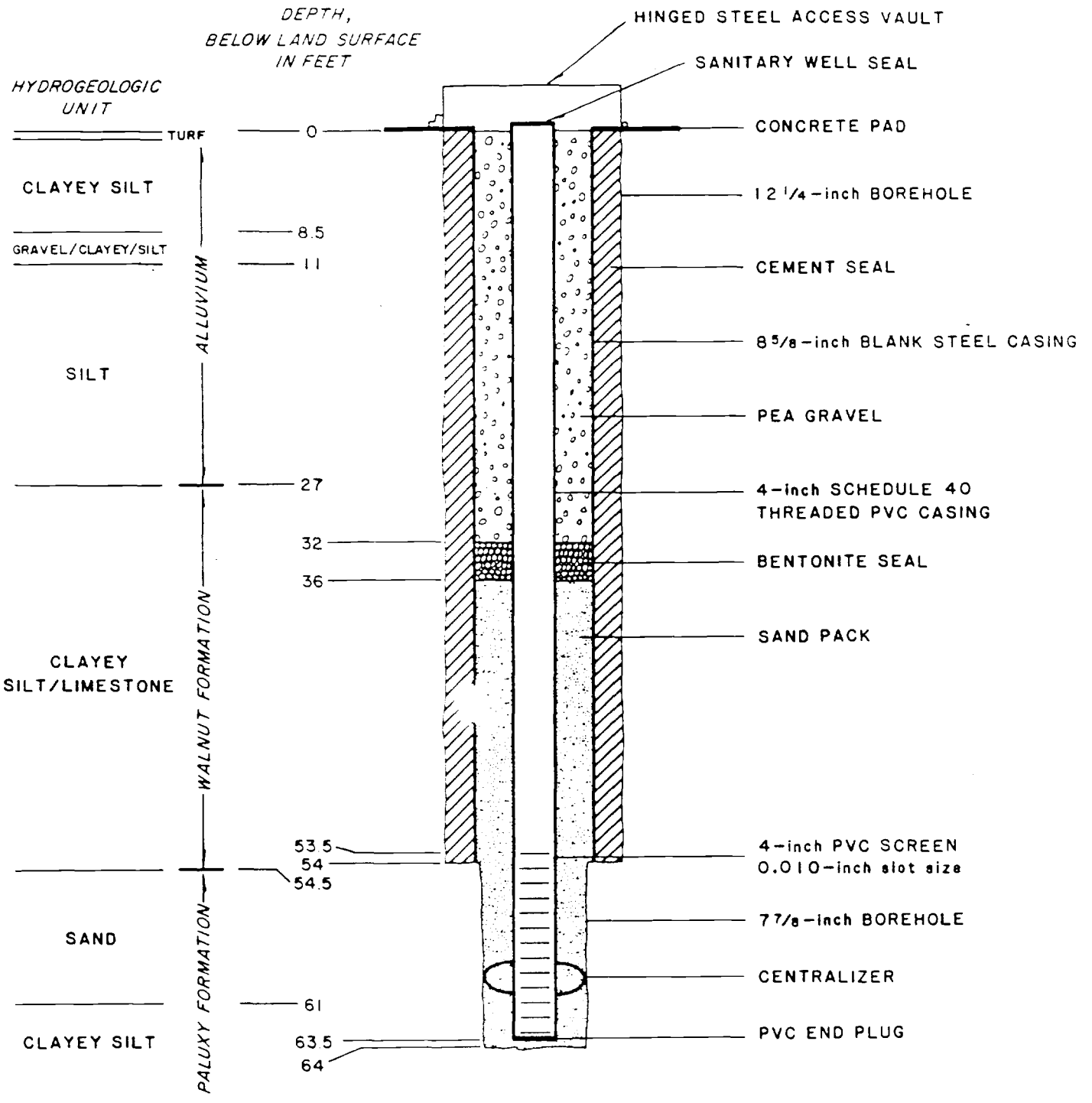

FIGURE F-11. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-13US

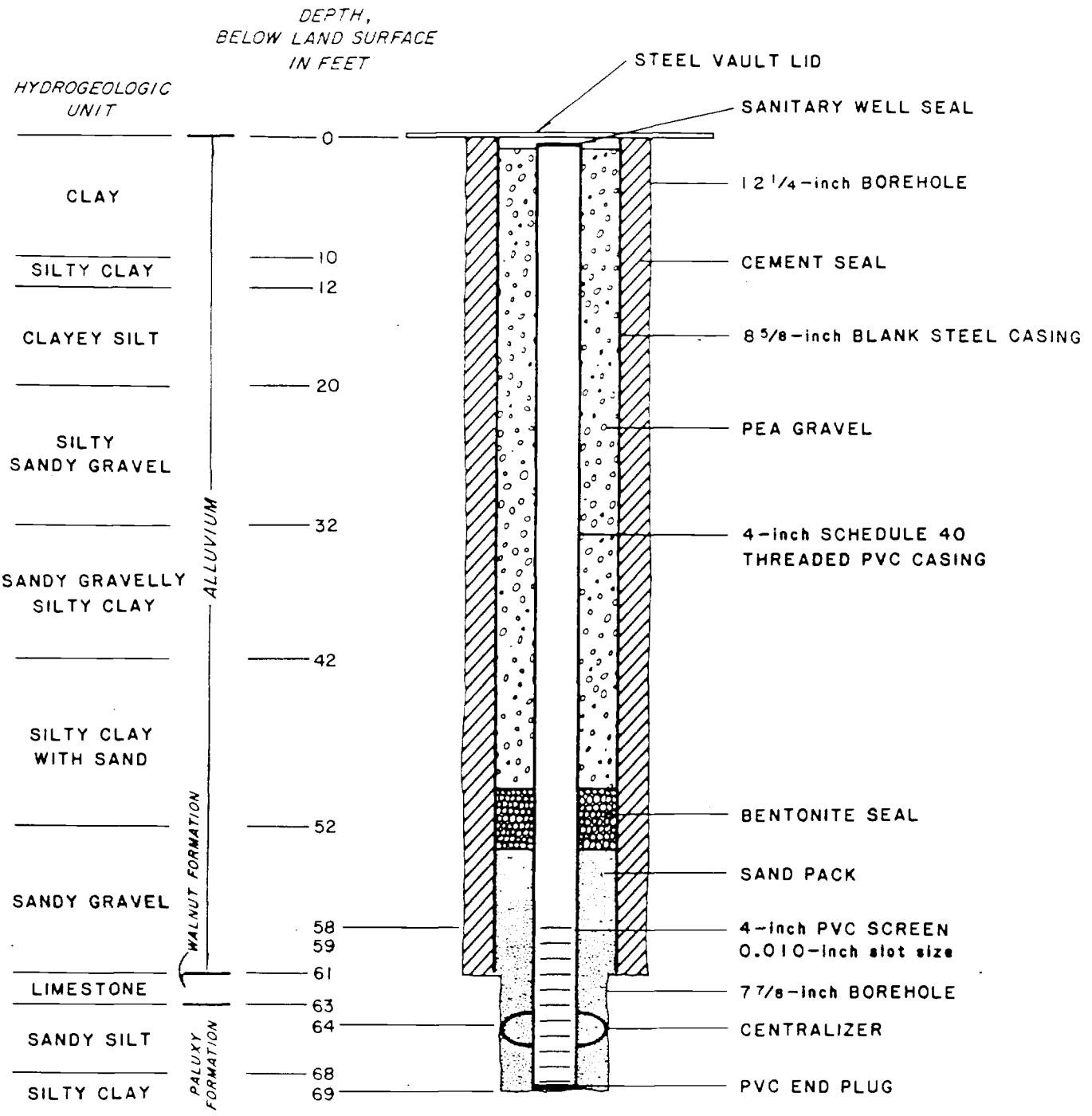

FIGURE F-12. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-15US

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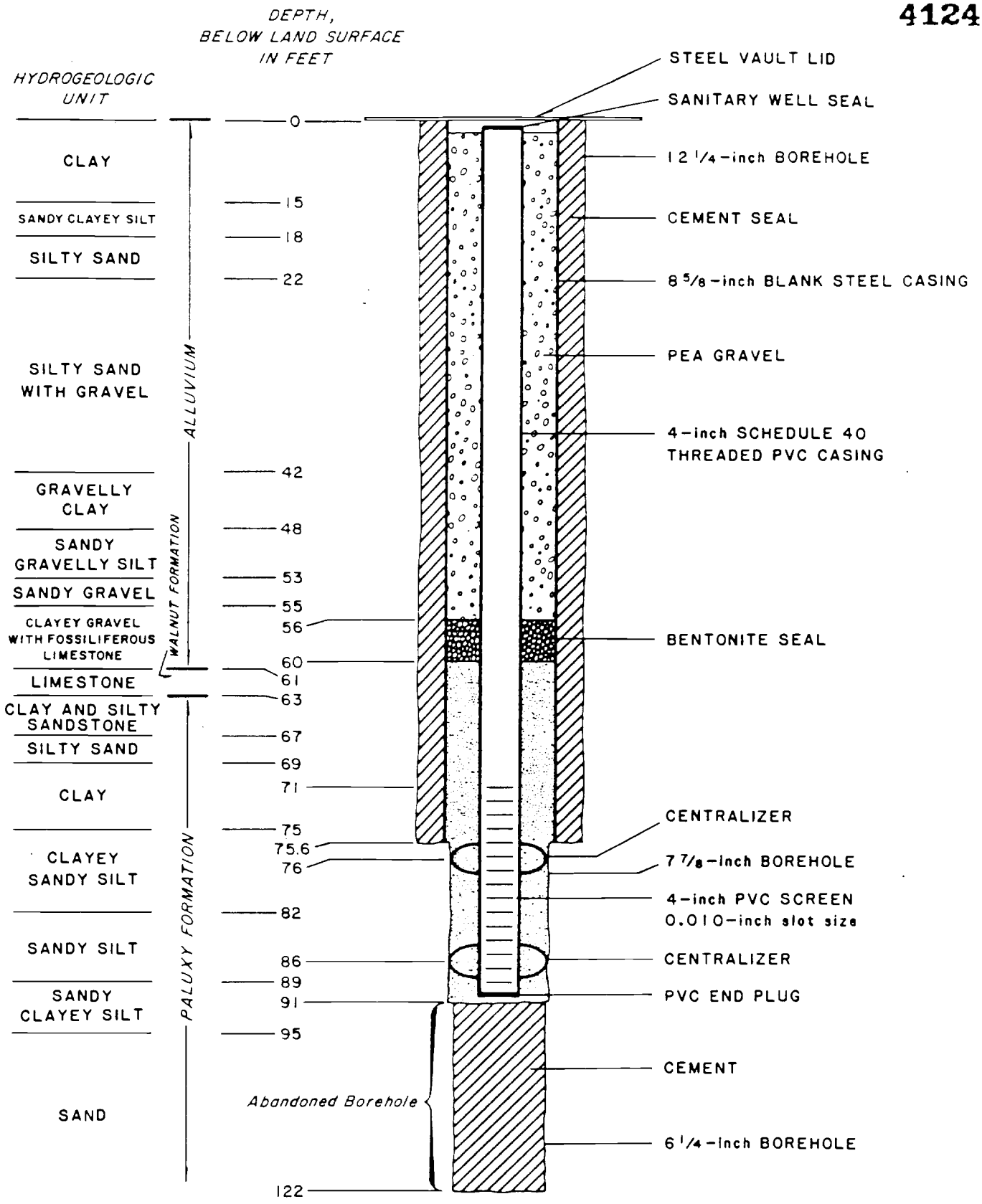

FIGURE F-13. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-15U

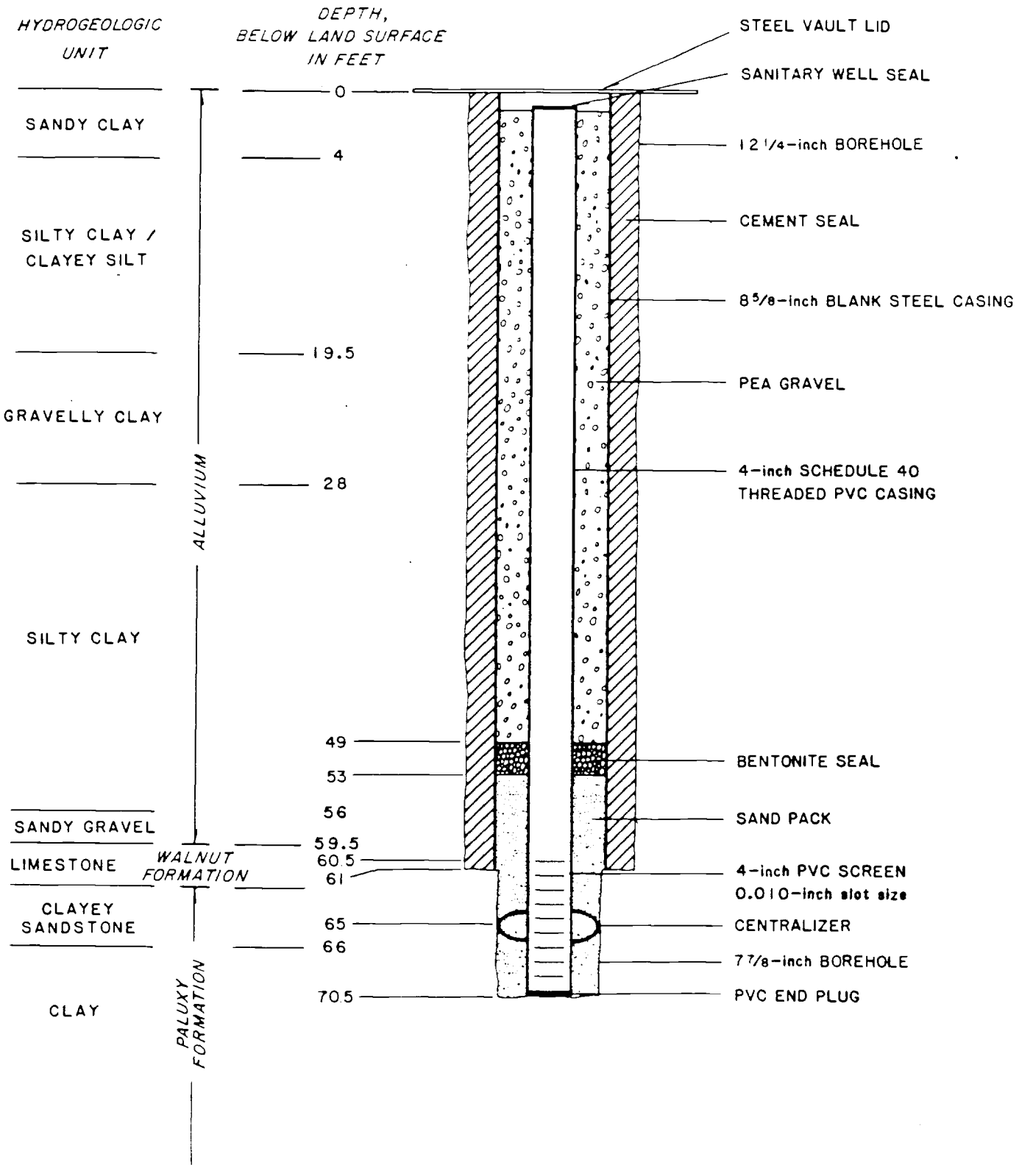

FIGURE F-14. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-16US

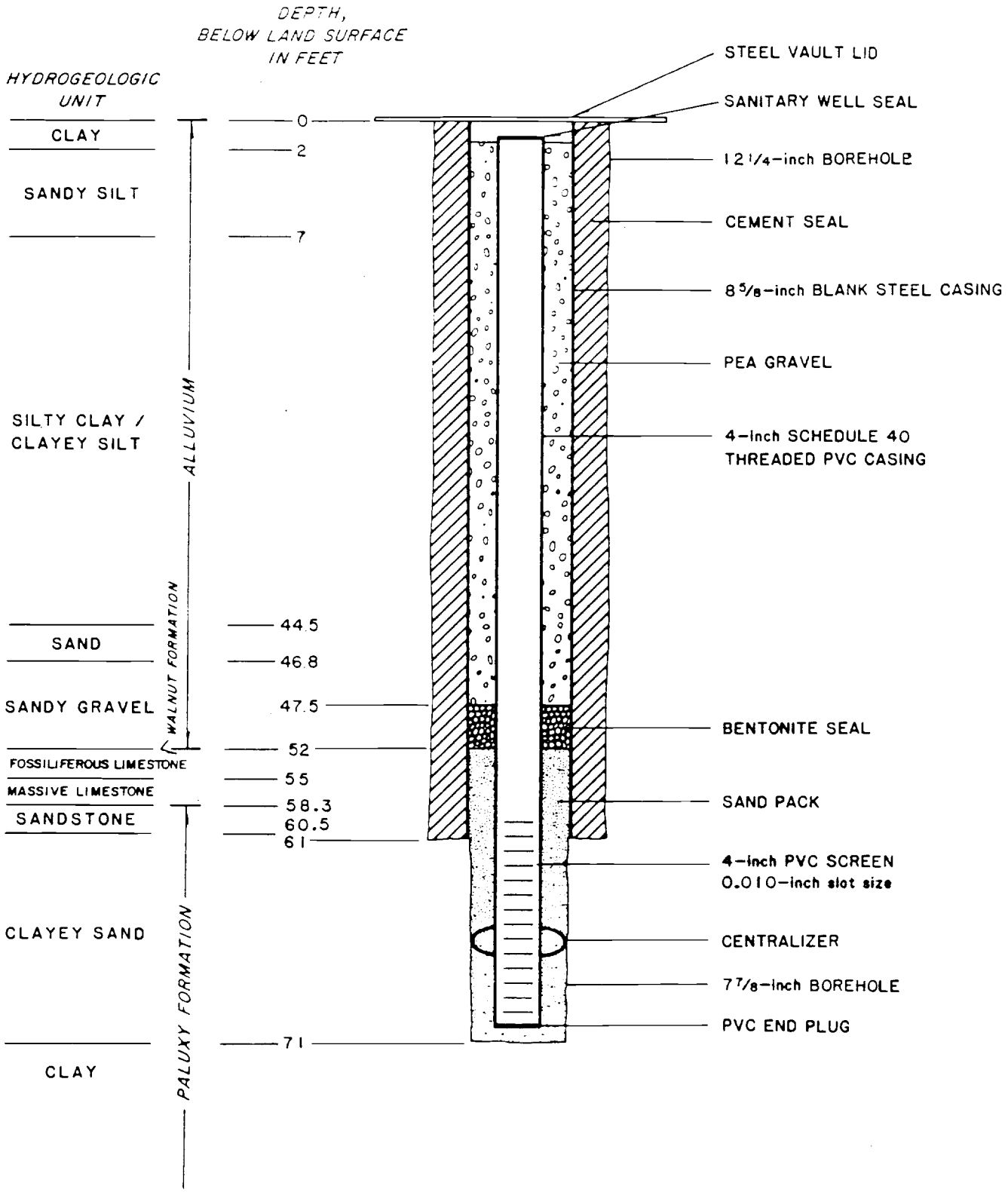

FIGURE F-15. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-17US

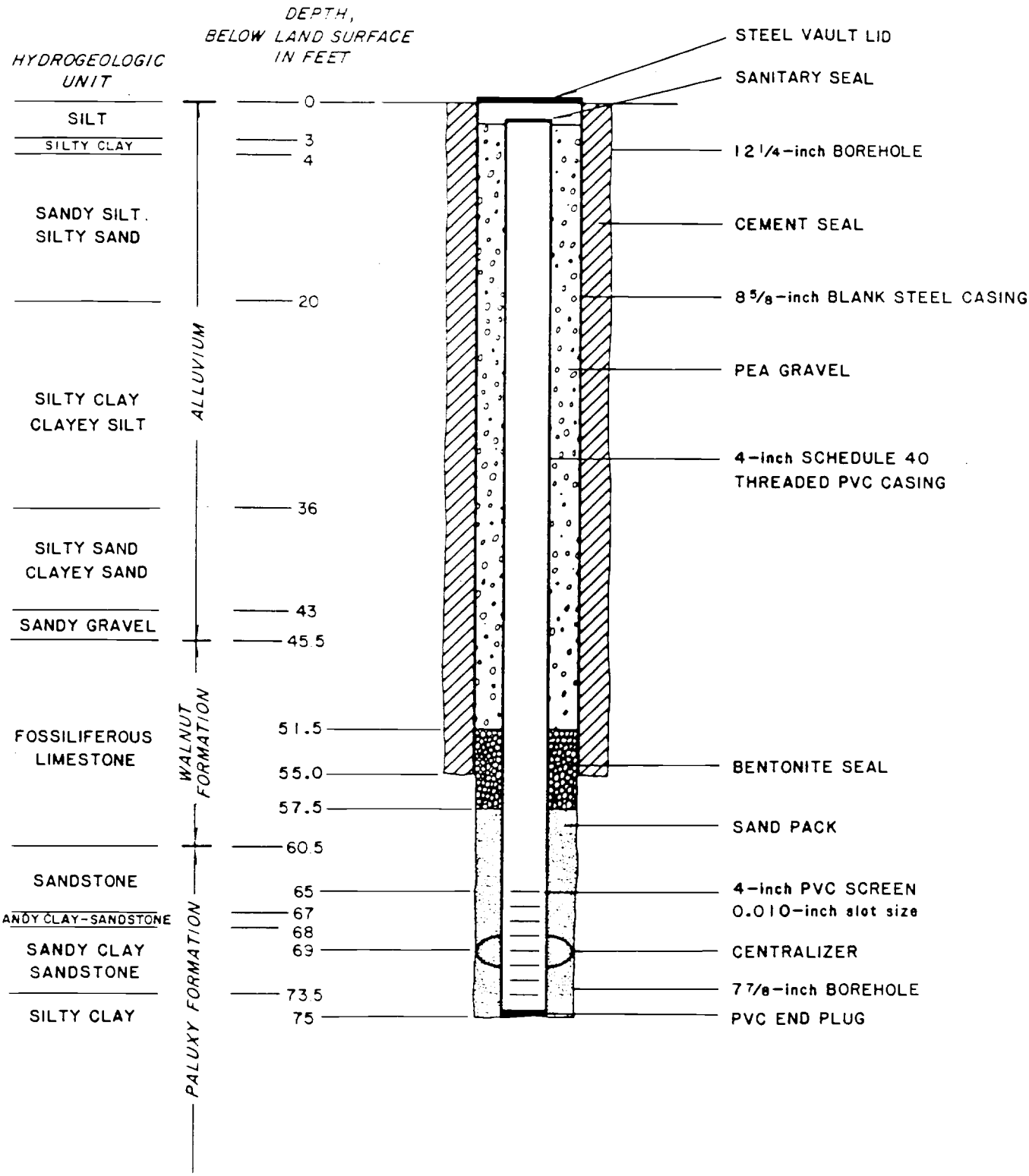

FIGURE F-16. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-18US

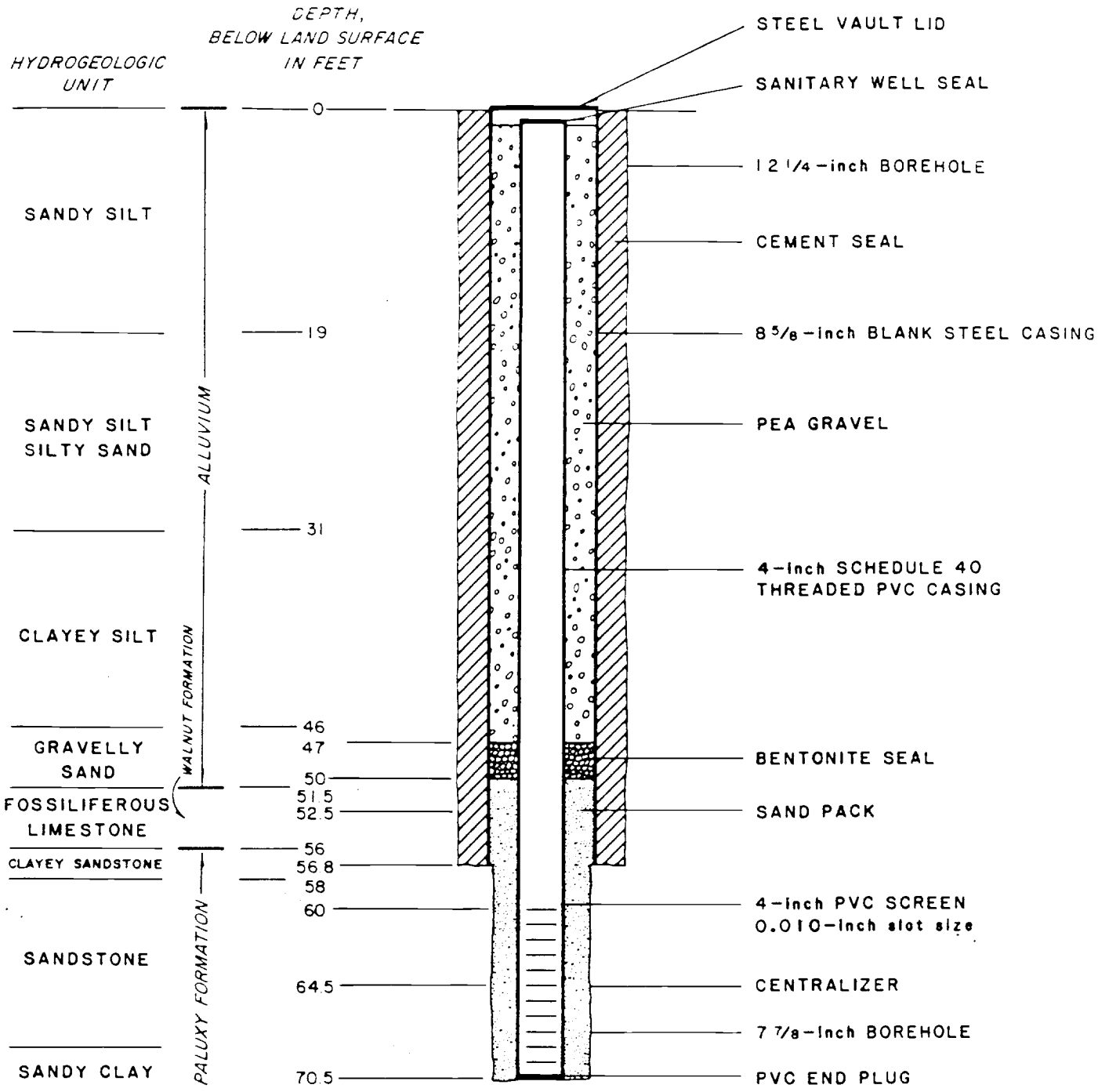

FIGURE F-17. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-19US

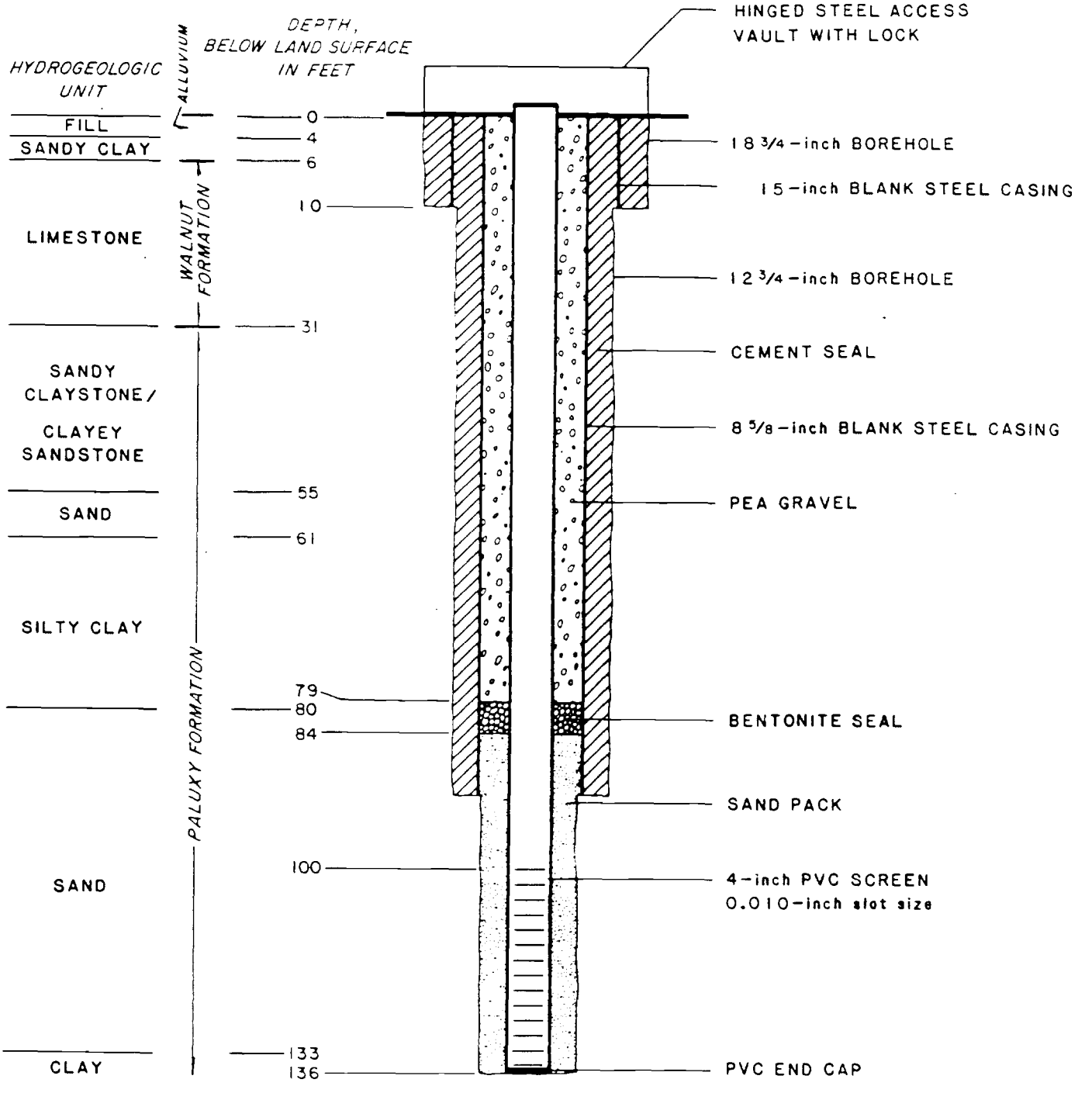

FIGURE F-18. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-22M

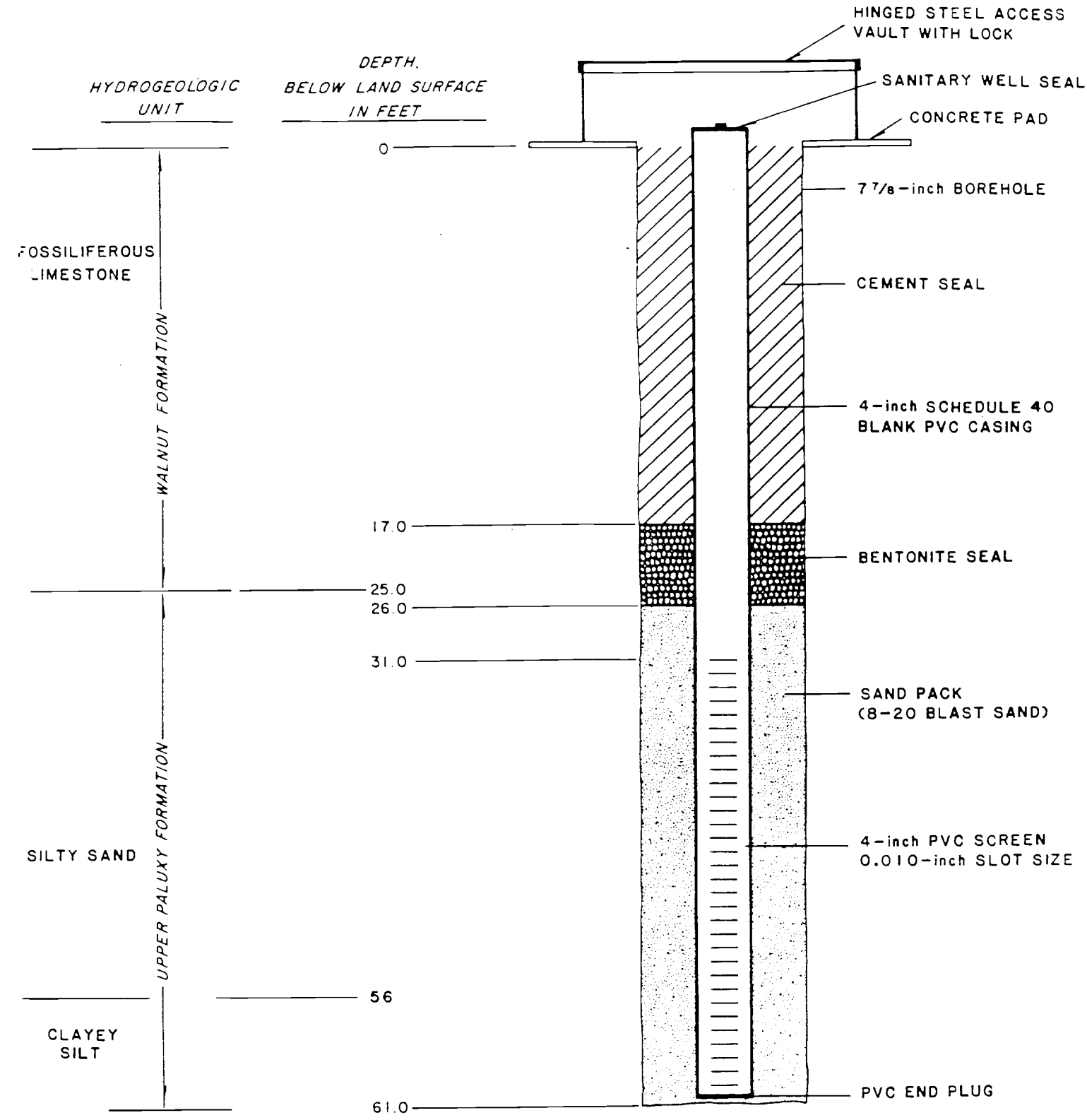

FIGURE F-19. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-24U

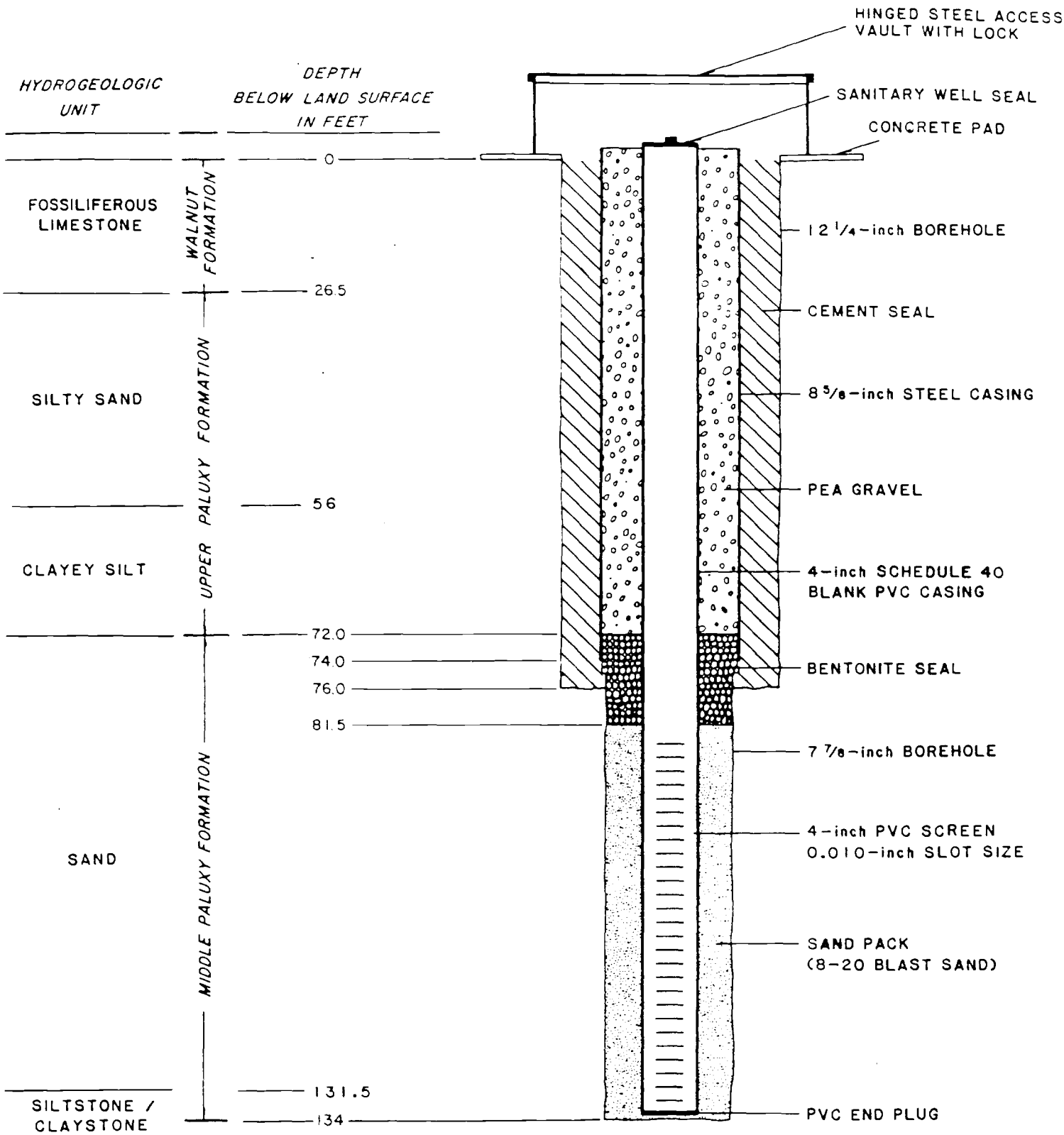

FIGURE F-20. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-24M

HARGIS + ASSOCIATES, INC.

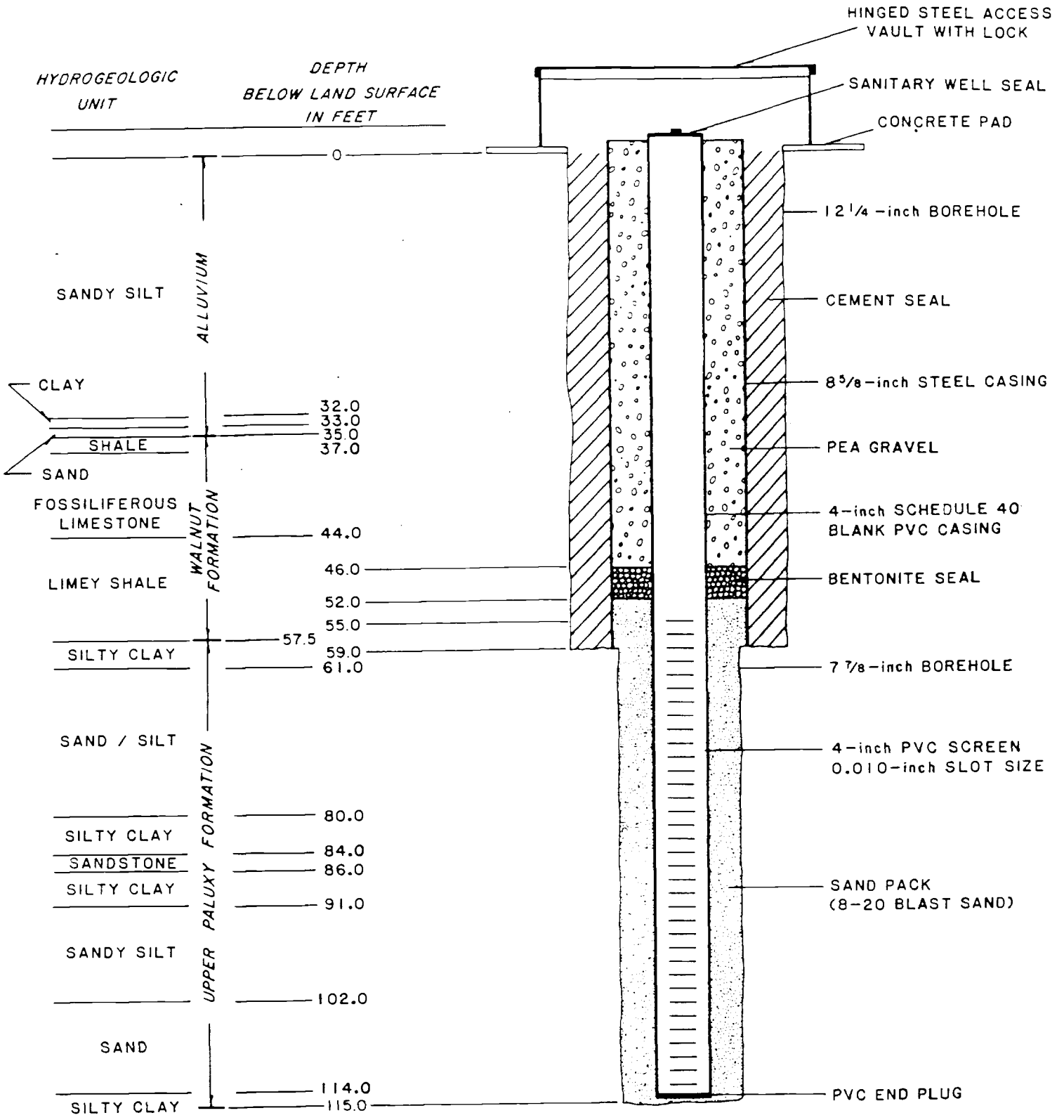

FIGURE F-21. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-25U

HARGIS + ASSOCIATES, INC.

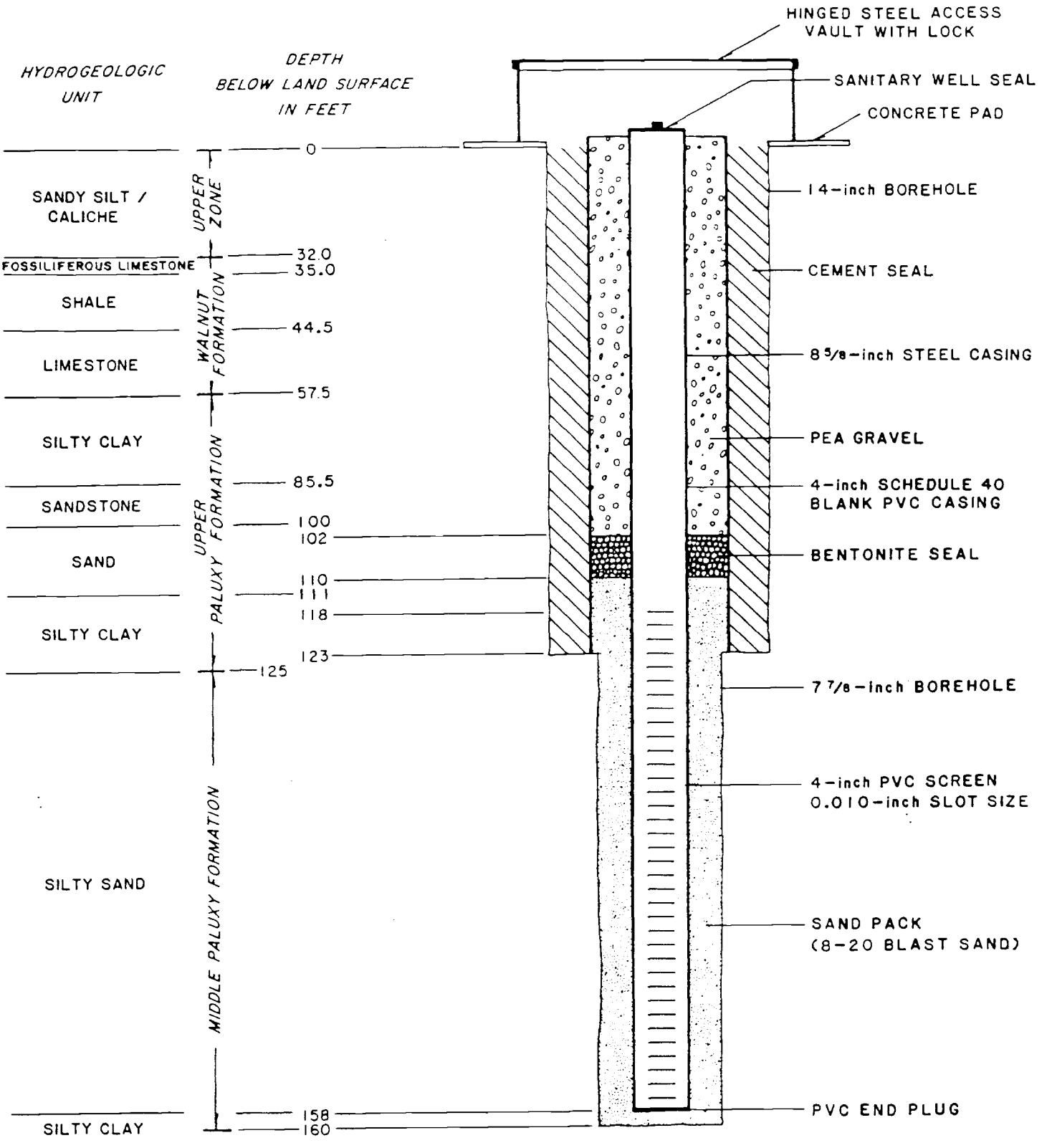

FIGURE F-22. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-25M

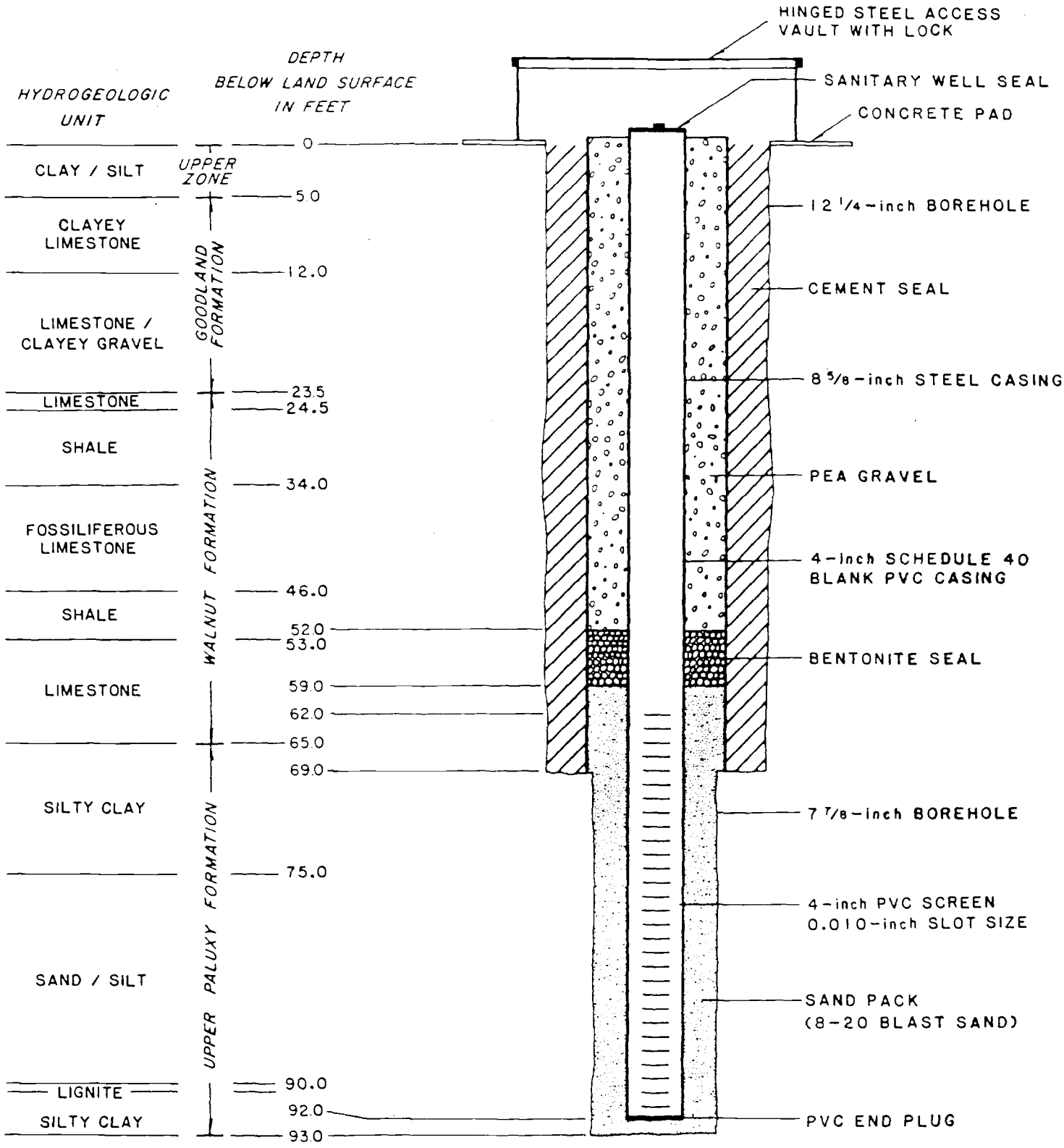

FIGURE F-23. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-26U

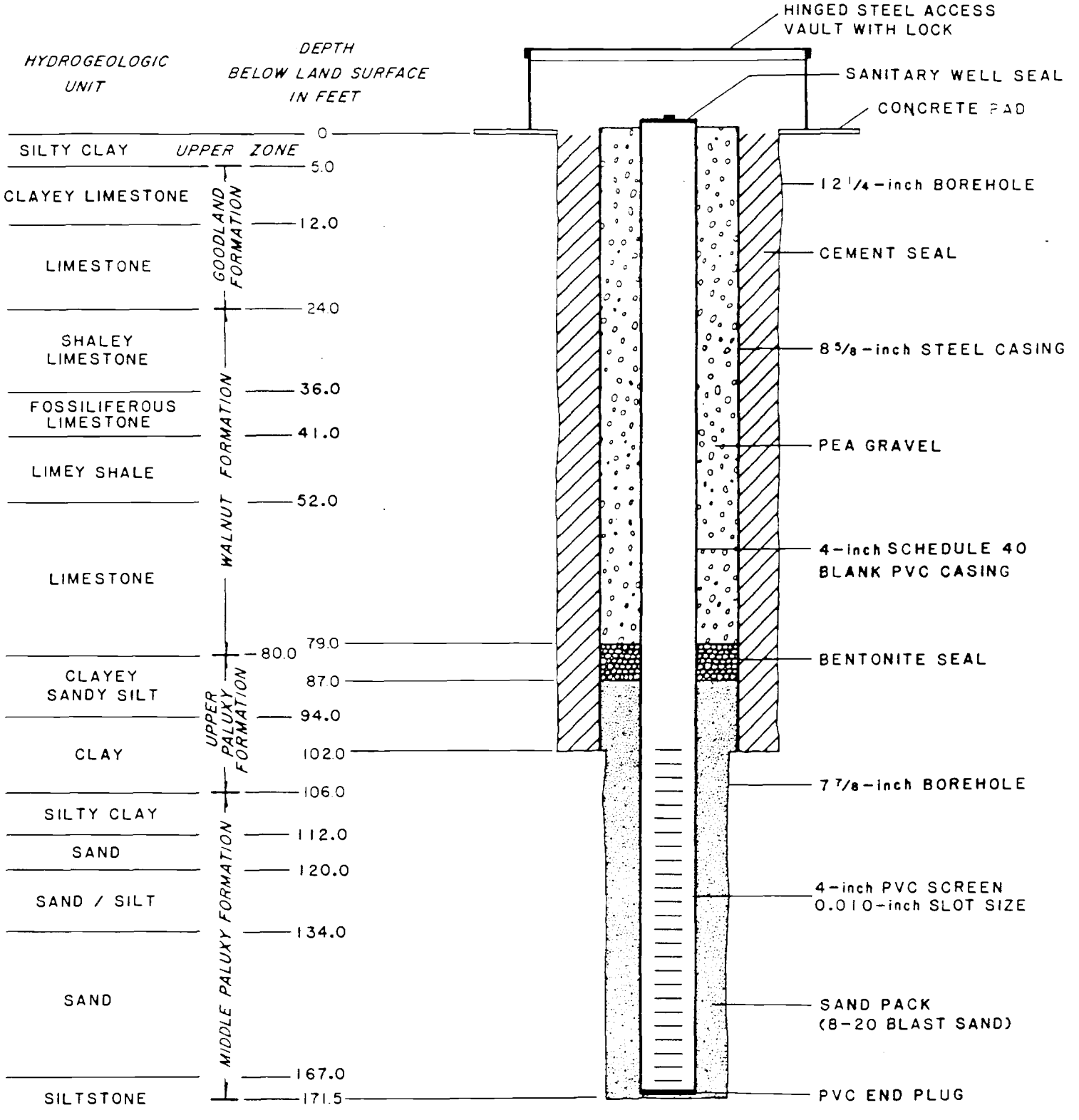

FIGURE F-24. SCHEMATIC CONSTRUCTION DIAGRAM FOR MONITOR WELL P-26M

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